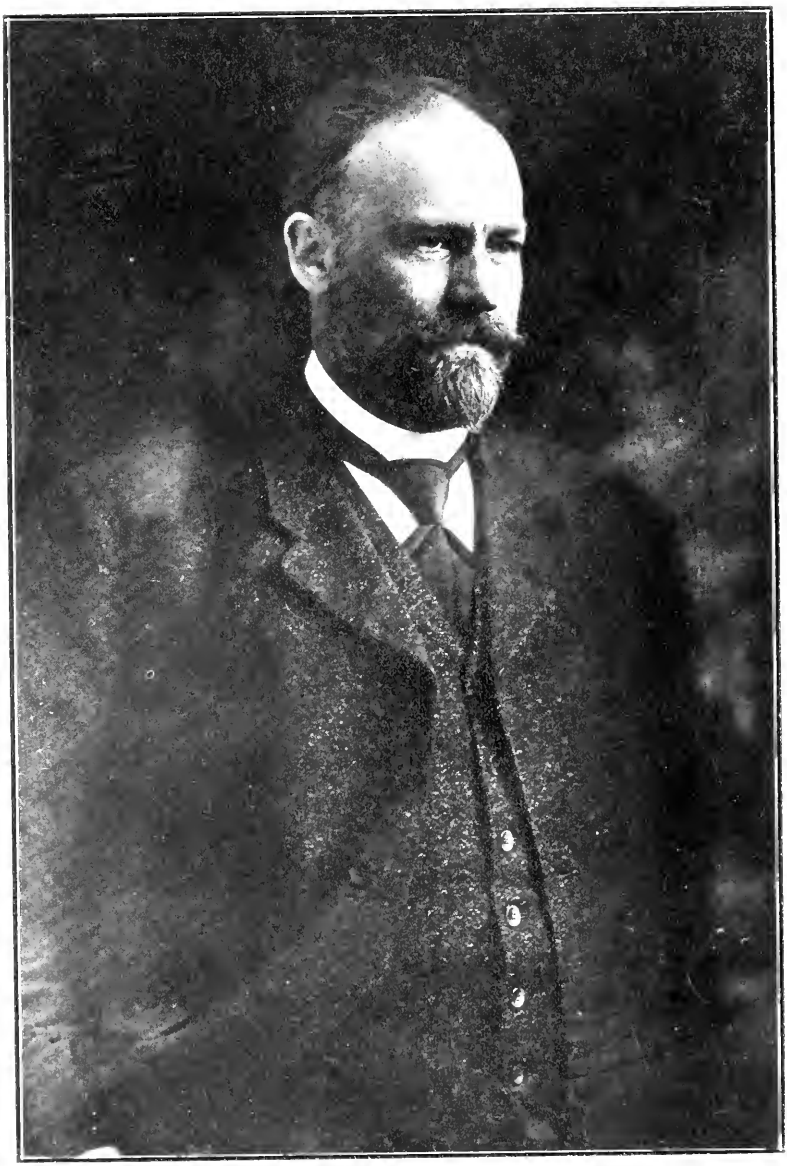

HENRY AUGUST HUNICKE.

TRANSACTIONS

OF

THE ACADEMY OF SCIENCE OF ST. LOUIS.

VOL. XVIII.

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CORRECTION.

P. 63, line 3 from bottom—For *M. clavisetosa,* read *M. clavisetosus.*

LIST OF OFFICERS, 1908.

PRESIDENT	Calvin M. Woodward.
FIRST VICE PRESIDENT	Arthur Thacher.
SECOND VICE PRESIDENT	Launcelot W. Andrews.
RECORDING SECRETARY	Samuel M. Coulter.
CORRESPONDING SECRETARY	H. August Hunicke.
TREASURER	Charles D. Stevens.
LIBRARIAN	Mary J. Klem.
CURATORS	Frank Schwarz.
	Julius Hurter.
	Mary J. Klem.
DIRECTORS	Francis E. Nipher.
	Otto Widmann.

LIST OF OFFICERS, 1909.

PRESIDENT	William Trelease.
FIRST VICE PRESIDENT	Arthur Thacher.
SECOND VICE PRESIDENT	Launcelot W. Andrews.
RECORDING SECRETARY	Walter Edward McCourt.
CORRESPONDING SECRETARY	H. August Hunicke.
	George T. Moore.*
TREASURER	Charles D. Stevens.
LIBRARIAN	Mary J. Klem.
CURATORS	Julius Hurter.
	Otto Widmann.
	Joseph Grindon.
DIRECTORS	Francis E. Nipher.
	Chester B. Curtis.

*October 18, 1909, Professor George T. Moore was elected by the Council to fill the office of Corresponding Secretary made vacant by the death of Dr. H. August Hunicke, on April 5, 1909.

MEMBERS.

1. Patrons.

Eliot, Henry W.....4446 Westminster Pl.

†Harrison, Edwin.....

McMillan, Mrs. Eliza.....25 Portland Pl.
McMillan, William Northrop...Century Bldg.

2. Honorary Members.

Arrhenius, Prof. Svante.....University of Stockholm, Sweden.

Bahlsen, Prof. Dr. Leopold....University of Berlin, Germany.

Escherich, Prof. Theodore.....University of Vienna, Austria.

Kitasato, Prof. Shibasaburo...University of Tokyo, Japan.

Lewald, Geh. Oberreg. Rath Theodor .....Berlin, Germany.
Limburg, Stirum, Graf.....Berlin, Germany.

Orth, Geh. Rath Dr. Johann...University of Berlin, Germany,
Ostwald, Prof. Wilhelm.....University of Leipzig, Germany.

Ramsay, Sir William.....Royal Institute, London, England.

Rutherford, Prof. Ernest.....University of Manchester, England.

Sander, Dr. Enno.....St. Louis, Mo.
Springer, Frank .....Burlington, Iowa.

Van't Hoff, Prof. J. W.....University of Berlin, Germany.

Waldeyer, Geh. Rath Prof. Dr. Wilhelm .....University of Berlin, Germany.
Wassermann, Prof. Dr. A.....University of Berlin, Germany.
Wittmack, Geh. Reg. Rath Prof. Dr. L.....University of Berlin, Germany.

† Deceased.

3. Active Members.

Abbott, James F.[2].....Washington University.
Adkins, James .....Park and Vandeventer Avs.
Alleman, Gellert[1].....Swarthmore College,
Swarthmore, Pa.
Allen, George L.....26 Westmoreland Pl.
Allen, Terry W.....5061 Lindell Boul.
Alt, Adolf .....316 Metropolitan Bldg.
Altheimer, Benjamin .....4349 Westminster Pl.
Ameiss, F. C.....3906 Olive St.
Ammerman, Charles.....McKinley High School.
Andrews, Launcelot W.....3731 Westminster Pl.
Arbuckle, James .....Stock Exchange Bldg.
Armbruster, Wm. J.....3622 Shenandoah St.

Baer, Paul R.....2003 Fair Ave.
Bagby, Julian[1].....New Haven, Mo.
Bain, Samuel McCutchen[1]....University of Tennessee,
Knoxville, Tenn.
Barck, Carl.....Humboldt Bldg.
Barnard, George D.....Vandeventer and Laclede Aves.
Barroll, Joseph R.....4603 Berlin Ave.
Bartlett, George M.[1].....R. F. D. No. 2, Gardner, Mass.
Baskett, James Newton[1].....Mexico, Mo.
Baumgarten, Gustav .....4171 Washington Boul.
Baumgarten, Walter.....Humboldt Bldg.
Bay, J. Christian[1].....Crerar Library, Chicago, Ill.
Bernays, Walter .....3623 Laclede Ave.
Bessey, Charles Edwin[1].....University of Nebraska,
Lincoln, Neb.
Bessey, Ernst A.[1].....Louisiana State University,
Baton Rouge, La.
Bixby, William Keeney.....Kingshighway and Lindell Bls.
Blair, V. P.....Metropolitan Bldg.
Blankinship, Joseph William[1].4008a Flad Ave.
Blewett, Ben .....Ninth and Locust Sts.
Bock, George W.[2].....2904 Allen Ave.

[1] Non-resident.
[2] Member of the Entomological Section.

Boeckeler, William L.....4441 Laclede Ave.
Bostwick, Arthur E.....4654 Berlin Ave.
Boyle, Wilbur F.....New Bank of Commerce Bldg.
Brandenburger, W. A.....1001 Liggett Bldg.
Brannon, Melvin A.[1].....University of North Dakota, Grand Forks, N. Dak.
Brennan, Martin S.....6304 Minnesota Ave.
Brimmer, George G.....6900 Michigan Ave.
Britton, F. H.[1].....Kirkwood, Mo.
Brockman, F. W.....3710 N. Grand Ave.
Brookings, Robert S.....5125 Lindell Boul.
Brown, Arthur A.....4023 West Pine Boul.
Brown, Daniel S.....2212 DeKalb St.
Brown, George Warren.....40 Portland Pl.
Brown, Willi.....5351 Waterman Ave.
Browne, Clarence I.....4630a Delmar Ave.
Buckley, Ernest Robertson[1]...Rolla, Mo.
Buehler, H. A.[1].....Rolla, Mo.
Burg, William .....4323 Washington Boul.
Burnett, E. C.....University Club.
Busch, Adolphus .....Busch Pl.
Busch, Aug. A.....Busch Pl.
Bush, Benjamin Franklin[1]....Courtney, Mo.
Bushnell, D. I.....4254 Olive St.
Butler, William M.....Yeatman High School.

Cale, George W., Jr.....12 Lennox Pl.
Carleton, Murray .....1135 Washington Ave.
Carpenter, George O.....12 Portland Pl.
Carr, Peyton T.....62 Vandeventer Pl.
Carter, Howard[1] .....Webster Groves, Mo.
Carver, George Washington[1]...Tuskegee, Ala.
Caspari, Charles E.....4060 Westminster Pl.
Catlin, Daniel .....Security Bldg.
Chandler, Harley P.....5539 Page Ave.
Chappell, W. G.....Buckingham Club.
Chenery, Winthrop Holt.....Washington University.
Chouteau, Pierre .....912 Security Bldg.
Christie, Harvey L.....1605 Pierce Bldg.
Clarke, Enos[1] .....Kirkwood, Mo.
Clopton, Malvern B.....Humboldt Bldg.

Cole, John J.....4023 Westminster Pl.
Colnon, R. S.....506 Merchants' Laclede Bldg.
Conzelman, Theophilus .....5260 Washington Boul.
Cook, Francis E.....4419 Morgan St.
Coulter, Samuel M.....Washington University.
Craig, Moses .....Missouri Botanical Garden.
Cramer, Gustav .....Care Cramer Dry Plate Co.
Crandall, George C.....4283 Olive St.
Crawford, Hanford .....4442 Lindell Boul.
Crook, A. R.[1].....State Natural History Museum, Springfield, Ill.
Crunden, Frank P.....Second and Gratiot Sts.
Cupples, Samuel .....3673 Pine St.
Curtis, Chester B.....Central High School.
Curtis, William S.....Washington University.

Dameron, Edward Caswell[1]....Clarksville, Mo.
Danforth, Charles H.....1806 Locust St.
Davis, Dwight F.....220 Security Bldg.
Davis, H. N.....56 Vandeventer Pl.
Davis, John D.....815 Merchants' Laclede Bldg.
DeMenil, Alexander N.....DeMenil Bldg.
Dewey, Lyster H.[1].....1337 Wallach Pl., Washington, D. C.
Dieckmann, Charles A.[2].....2816 Potomac St.
Diehm, Ferdinand .....6175 Kingsbury Pl.
Dodd, Samuel M.....53 Vandeventer Pl.
Dorsett, Walter B.....Linmar Bldg.
Dougan, Lewis M.[2].....Shaw School.
Douglas, Archer W.....5079 McPherson Ave.
Douglas, Stephen A.....Central High School.
Drosten, F. W.....2011 Park Ave.
Drushel, J. A.....Teachers' College.
Duncan, John H.....Humboldt Bldg.
Duncan, M. E.....915 Olive St.
Duncker, Charles H.....3636 Page Ave.

Eberle, E. G.[1].....416 Jackson St., Dallas, Texas.
Eimbeck, August F.[1].....New Haven, Mo.
Eliot, Edward C.....5468 Maple Ave.
Emmel, Victor E.....1806 Locust St.

Engler, Edmund Arthur[1].....11 Boynton St.,
Worcester, Mass.
Ericson, Eric John .....1420 Clara Ave.
Erker, Adolph P.....604 Olive St.
Espenschied, Charles .....3500 Washington Ave.
Euston, Alexander .....3730 Lindell Boul.
Evers, Edward .....1861 North Market St.
Ewing, Arthur E.....5956 West Cabanne Pl.

Farr, Henry V.....4916 Labadie Ave.
Fawcett, H. S.[1].....Gainesville, Fla.
Ferriss, James H.[1].....Joliet, Ill.
Filley, John D.....40 Westmoreland Pl.
Fisch, Carl .....3212 Pine St.
Fischel, Washington E.....Humboldt Bldg.
Fordyce, John R.[1].....2223 Louisiana St.,
Little Rock, Ark.
Fordyce, S. W.....21 Washington Terrace.
Francis, David R.....4421 Maryland Ave.
French, George Hazen[1].....Carbondale, Ill.
Frerichs, Frederick W.....3828 Westminster Pl.
Frick, John Henry[1].....Warrenton, Mo.
Fruth, Otto J.....3060 Hawthorne Boul.
Fry, Frank R.....4609 McPherson Ave.
Fuhrmann, Richard H.....3221 California Ave.
Fullgraf, Charles W.....7077 Pernod Ave.
Funkhouser, Robert Monroe..4354 Olive St.
Furth, Jacob .....723 Pierce Bldg.

Gager, C. Stuart[1].....Horticultural Bldg.,
Columbia, Mo.
Garman, Harrison[1] .....Lexington, Ky.
Garneau, Henry C.....Cupples Station.
Gates, Reginald R.....Missouri Botanical Garden.
Gecks, Frank .....3453 Magnolia Ave.
Geitz, H. A.....3126 Washington Ave.
Gerling, H. J.....Teachers' College.
Gifford, William L. R.....Mercantile Library.
Gillette, C. P.[1].....Fort Collins, Colo.
Glasgow, Frank A.....3894 Washington Ave.
Glatfelter, Noah Miller.....4720 North Twentieth St.

Goldstein, Max A.....3858 Westminster Pl.
Goodman, Charles H.....4500 Olive St.
Gratz, Benjamin .....Rialto Bldg.
Graves, William W.....Metropolitan Bldg.
Greger, Darling Kennett[1].....Westminster College, Fulton, Mo.
Green, John .....2670 Washington Ave.
Greer, E. O.....2750 Park Ave.
Gregg, Cecil D.....920 Market St.
Grindon, Joseph .....3894 Washington Ave.
Gundelach, Charles H.....4523 Washington Boul.
Gundelach, William J.....4477 Washington Boul.
Gundlach, John H.....3615 North Broadway.
Guy, William E.....10 Portland Pl.

Haarstick, Henry C.....St. Louis Union Trust Bldg.
Hambach, Gustav[3] .....2061 San José Avenue, Alameda, California.
Hard, M. E.[1].....Kirkwood, Mo.
Harder, Ulrich .....8015 Florissant Ave.
Harris, James Arthur[1].....Station for Experimental Evolution, Cold Spring Harbor, Long Island, N. Y.
Hartmann, Rudolph .....3857 Flora Boul.
Held, George A.....International Bank.
Hendrick, Walter F.....6228 Washington Boul.
Herf, Oscar .....48 Gay Bldg.
Higdon, W. D.....McKinley High School.
Hilliard, Henry P.....St. Louis Club.
Hoffman, Philip .....3337 Washington Ave.
Holmes, J. A.....Tenth and Spruce Sts.
Homan, George .....323 Odd Fellows' Bldg.
Hough, Warwick .....5884 Cates Ave.
Hughes, Charles Hamilton....3858 West Pine St.
Hume, H. Harold[1].....Glen St. Mary, Fla.
Hurter, Julius .....2346 South Tenth St.
Hus, Henri Th. A.[1].....University of Michigan, Ann Arbor, Mich.
Huttig, Charles H.....Third National Bank.

[3] Elected a life-member January 3, 1882.

Ilhardt, William K.....Euclid and Delmar Aves.
Irish, Henry C.....Missouri Botanical Garden
Ives, Halsey Cooley.....Museum of Fine Arts.

James, G. O.....Washington University.
Jones, Robert McKittrick.....6 Westmoreland Pl.

Kaime, David F.....619 Chestnut St.
Kammerer, Alfred L.....Tower Grove and Flad Aves.
Keiser, Edward H.....Washington University.
Kennett, Alfred Q.....Washington University.
Kessler, J. J.....224 South Vandeventer Ave.
Keyes, Charles R.[1].....944 Fifth St., Des Moines, Ia.
Kinealy, John H.....503 Granite Bldg.
King, Goodman .....78 Vandeventer Pl.
Kirchner, Walter C. G.....City Hospital.
Klein, Jacob .....5099 Westminster Pl.
Klem, Mary J.....3133 Nebraska Ave.
Knapp, H. P.....Eighteenth and Olive Sts.
Kotany, M.....409 Olive St.

Lackland, Rufus J.....1623 Locust St.
Lang, George, Jr.....213 North Second St.
Lange, Richard C.....4403 Arco Ave.
Langsdorf, Alexander S.....Washington University.
Larkin, E. H.....109 St. George St.
Leavitt, Sherman[1] .....University of Tennessee, Knoxville, Tenn.
Lefevre, George[1] .....University of Missouri, Columbia, Mo.
Leonori, Rufus U.....3507 Lafayette Ave.
Letterman, George W.[1].....Allenton, Mo.
Lewis, E. G.[1].....University City, Mo.
Lichter, John J.....1740 Simpson Pl.
Lloyd, Francis Ernest[1].....Alabama Polytechnic Institute, Auburn, Ala.
Lloyd, Hiram .....Odd Fellows' Bldg.
Loeb, Hanau Wolf.....Humboldt Bldg.
Lovejoy, Arthur Onchen[1].....411 Hitt St., Columbia, Mo.

MacDougal, D. T.[1].....Tucson, Ariz.
Mack, Charles Jacob.....113 North Broadway.

Malkmus, F. .....4398½ Gibson St.
Mallinckrodt, Edward .....26 Vandeventer Pl.
Mallinckrodt, Edward, Jr.....26 Vandeventer Pl.
Mardorf, W. C.....3634 Shenandoah Ave.
Markham, George Dickson....4961 Berlin Ave.
Mason, Silas C.[1].....5035 Echo St., Los Angeles, Cal.
Matthews, Leonard .....300 North Fourth St.
Mauran, John Lawrence.....1620 Chemical Bldg.
McBride, W. J.[1].....Haskell & Barker Car Co., Michigan City, Ind.
McCourt, Walter Edward.....Washington University.
McCulloch, Richard .....3869 Park Ave.
McCulloch, Robert .....3869 Park Ave.
McKittrick, Thomas H.....911 Washington Ave.
McLeod, N. W.....Lumbermen's Bldg.
Meier, Theodore G.....5220 Washington Boul.
Merrell, Albert .....3814 Washington Boul.
Mesker, Frank .....421 South Sixth St.
Meyer, Andrew, Jr.....3218a Missouri Ave.
Meyer, Jesse S.....3894 Washington Boul.
Monell, Joseph T.[2].....3454 Halliday Ave.
Moore, George T.....Missouri Botanical Garden.
Moore, Robert .....61 Vandeventer Pl.
Morrison, Gilbert .....McKinley High School.
Mudd, Harvey G.....408 Humboldt Bldg.
Mueller, Ambrose[1] .....Webster Groves, Mo.

Nagel, Charles .....3726 Washington Boul.
Nasse, August .....2323 Lafayette Ave.
Nelson, Aven[1] .....Laramie, Wyoming.
Nelson, N. L. T.....Central High School.
Nicolaus, Henry .....2149 South Grand Ave.
Nipher, Francis E.....Washington University.
Nisbet, Fritz .....1101 Locust St.
Noble, John W.....3043 Pine St.

Oglevee, Christopher Stoner[1]..Lincoln, Ill.
Ohlweiler, W. W.....Missouri Botanical Garden.
Olshausen, Ernest P.....1115 Rutger St.
O'Reilly, Andrew J.....2207 South Grand Ave.

O'Reilly, Robert J.....27 Washington Terrace.
Outten, W. B.....3515 Pine St.

Palmer, Ernest Jesse[1].....321 S. Allen St.,
Webb City, Mo.
Pammel, Louis Hermann[1]....Ames, Iowa.
Pantaleoni, Guido .....15 Lennox Pl.
Parker, George Ward[1].....45 Broadway, New York City.
Pennock, C. J.[1].....Kennett Square,
Chester Co., Pa.
Perkins, Albert T.....401 Locust St.
Pettus, Charles P.....33 Westmoreland Pl.
Pettus, W. H. H.....4373 Westminster Pl.
Pitzman, Julius .....1900 South Compton Ave.
Plant, Frederick S.....802 North Main St.
Poats, Thomas Grayson[1].....Clemson College, S. C.
Post, Martin Hayward.....5371 Waterman Ave.
Prynne, Charles Martyn.....Century Bldg.
Pyle, Lindley .....5575 Vernon Ave.

Randolph, Tom .....4386 Lindell Boul.
Rassieur, Leo .....Fourth and Market Sts.
Rathmann, Charles G.....3886 Hartford St.
Rau, Philip[2] .....5139 Shaw Ave.
Ravold, Amand .....5248 Vernon Ave.
Reber, Maxine .....301 New City Hall.
Redlich, C. F.....Nat'l Bank of Commerce Bldg.
Reed, George M.[1].....809 Virginia Av.,Columbia, Mo.
Rice, Charles M.....3733 West Pine Boul.
Ricker, Maurice[1] .....1039 Nineteenth St.,
Des Moines, Iowa.
Ridgely, Franklin L.....3720 Lindell Boul.
Robarts, Heber .....5899 Cates Ave.
Robert, Edward Scott.....4140 Lindell Boul.
Roever, William Henry.....Washington University.
Rolfs, F. M.[1].....Mountain Grove, Mo.
Rolfs, Peter H.[1].....Gainesville, Fla.
Rosenwald, Lucian[1] .....412 Delaware St.,
Kansas City, Mo.
Ruf, Frank A.....5863 Cabanne Pl.
Ryan, Frank K.....Times Bldg.

Sale, Samuel .....4621 Westminster Pl.
Sargent, Charles Sprague[1].....Jamaica Plains, Mass.
Sauer, William E.....Humboldt Bldg.
Scanlan, Philip C.....City Hall.
Scheffer, H. W.....3228 South Ninth St.
Schisler, Edwin .....2600 South Grand Ave.
Schlueter, Robert E.....909 Park Ave.
Schmidt, Louis .....Franklin Bank.
Schnell, L. W.[2].....4541 Varrelmann St.
Von Schrenk, Hermann.....Tower Grove and Flad Aves.
Schroers, John .....5236 Washington Boul.
Schrowang, Otto .....Panama Bldg.
Schwarz, Ernest[2] .....6310 Newstead Ave.
Schwarz, Frank .....1813 Lafayette Ave.
Schwarz, Henry .....440 North Newstead Ave.
Schwarz, Herman[2] .....720 Clark Ave.,
Tuxedo Park, Mo.
Schweitzer, Paul[1] .....Columbia, Mo.
See, Thomas Jefferson Jackson[1].Naval Observatory,
Mare Island, Cal.
Selby, Augustine Dawson[1]....Wooster, Ohio.
Senseney, E. M.....5738 Clemens Ave.
Senter, Charles Parsons.....1 Beverly Pl.
Shahan, William E.....5956 Cabanne Pl.
Shapleigh, Alfred Lee.....3636 Delmar Ave.
Shapleigh, John B.....Humboldt Bldg.
Shepley, John F.....3630 Delmar Boul.
Shimek, B.[1] .....Iowa City, Iowa.
Shoemaker, William Alfred...4386 Westminster Pl.
Shutt, C. H.....City Hospital.
Simmons, E. C.....Ninth and Spruce Sts.
Simmons, Wallace D.....Ninth and Spruce Sts.
Sluder, Greenfield .....3542 Washington Ave.
Smith, Arthur George[1].....Iowa City, Iowa.
Smith, D. S. H.....4388 Westminster Pl.
Smith, Irwin Z.....87 Vandeventer Pl.
Smith, Jared G.[1].....Kealakekua, Hawaiian Islands.
Spencer, H. N.....2725 Washington Ave.
Standley, Paul C.[1].....Division of Plants, National Museum, Washington, D. C.
Starkloff, H. M.....3623 Cleveland Ave.

Starr, John E.[1].....50 Church St., New York City.
Staudinger, B. .....3556 Lindell Boul.
Stevens, Charles D.....1749 South Grand Ave.
Stevens, Wyandotte James....4043 Juniata St.
Stix, Charles A.....Stix, Baer & Fuller Dry Goods Company.
Stocker, George J.....2833 South Kingshighway Bl.
Strecker, John K., Jr.[1].....Baylor University, Waco, Tex.
Studniczka, Henry .....2012 St. Louis Ave.
Stuyvesant, W. S.....5455 Maple Ave.
Sultan, Fred W.....112 North Second St.
Summa, Hugo .....Metropolitan Bldg.
Suppan, Leo .....2648 Russell Ave.

Taussig, William .....3447 Lafayette Ave.
Terry, Robert James.....1806 Locust St.
Thacher, Arthur .....5185 Lindell Boul.
Thomas, John R.....4128 Washington Boul.
Thompson, Charles Henry[2]...Missouri Botanical Garden.
Thurman, John S.....521 North Taylor Ave.
Timmerman, Arthur H.....5374 Vernon Ave.
Tittmann, Harold H.....5024 Westminster Pl.
Towner, M. E.....1129 Frisco Bldg.
Trelease, William .....Missouri Botanical Garden.
Tuholske, Herman .....465 North Taylor Ave.
Turner, Wilson P. H.....411 Olive St.
Tuttle, Daniel S.....74 Vandeventer Pl.
Tyler, Eliza Edward[1].....University of Missouri, Columbia, Mo.

Vallé, Jules F.....4955 Maryland Ave.
Van Ornum, John Lane.....Washington University.
Vickroy, Wilhelm Rees.....2901 Rauschenbach Ave.

Walbridge, C. P.....Fourth and Market Sts.
Waldo, C. A.....Washington University.
Walsh, Julius S.....Fourth and Pine Sts.
Watts, Millard F.....5740 Cabanne Pl.
Weber, George L.....6912 Bruno Ave.
Weller, Stuart[1] .....University of Chicago, Chicago, Ill.

Wells, Rolla .....4228 Lindell Boul.
Werner, Louis .....Fullerton Bldg.
Werner, Percy .....5505 Cates Ave.
Wheeler, H. A.....3439 Lucas Ave.
Whelpley, Henry Milton.....2342 Albion Pl.
Whitaker, Edwards .....300 North Fourth St.
Whitelaw, Oscar L.....409 North Second St.
Whitten, John Charles[1].....Columbia, Mo.
Widmann, Otto .....5105 Morgan St.
Wiedemann, H. E.....224 South Vandeventer Ave.
Wiener, Meyer .....3854 Westminster Pl.
Wilkus, Adolf .....612 Rutger St.
Winkelmeyer, Christopher ....3815 West Pine St.
Wislizenus, Frederick A.....Washington University.
Witt, Thomas D.....4374 Laclede Ave.
Wolfner, Henry L.....4563 Forest Park Boul.
Woodward, Calvin Milton.....Washington University.
Wright, George M.....4457 Westminster Pl.

Zahorsky, John .....1460 South Grand Ave.
Zellweger, John .....1900 Adelaide Ave.

ABSTRACT OF HISTORY.

ORGANIZATION.

The Academy of Science of St. Louis was organized on the 10th of March, 1856, in the hall of the Board of Public Schools. Dr. George Engelmann was the first President.

CHARTER.

On the 17th of January following, a charter incorporating the Academy was signed and approved, and this was accepted by a vote of the Academy on the 9th of February, 1857.

OBJECTS.

The act of incorporation declares the object of the Academy to be the advancement of science and the establishment in St. Louis of a museum and library for the illustration and study of its various branches, and provides that the members shall acquire no individual property in the real estate, cabinets, library, or other of its effects, their interest being merely usufructuary.

The constitution as adopted at the organization meeting and amended at various times subsequently, provides for holding meetings for the consideration and discussion of scientific subjects; taking measures to procure original papers upon such subjects; the publication of transactions; the establishment and maintenance of a cabinet of objects illustrative of the several departments of science and a library of works relating to the same; and the establishment of relations with other scientific institutions. To encourage and promote special investigation in any branch of science, the formation of special sections under the charter is provided for.

MEMBERSHIP.

Members are classified as active members, corresponding members, honorary members and patrons. Active

membership is limited to persons interested in science, though they need not of necessity be engaged in scientific work, and they alone conduct the affairs of the Academy, under its constitution. Persons not living in the city or county of St. Louis who are disposed to further the objects of the Academy, by original researches, contributions of specimens, or otherwise, are eligible as corresponding members. Persons not living in the city or county of St. Louis are eligible as honorary members by virtue of their attainments in science. Any person conveying to the Academy the sum of one thousand dollars or its equivalent becomes eligible as a patron.

Under the By-Laws, resident active members pay an initiation fee of five dollars and annual dues of six dollars. Non-resident active members pay the same initiation fee, but annual dues of three dollars only. Patrons and honorary and corresponding members are exempt from the payment of dues. Each patron and active member not in arrears is entitled to one copy of each publication of the Academy issued after his election.

Since the organization of the Academy, 1,187 persons have been elected to active membership, of whom, on December 31, 1909, 376 were carried on the list. Four patrons, Mr. Edwin Harrison, Mrs. Eliza McMillan, Mr. William Northrop McMillan and Mr. Henry W. Eliot, have been elected. The roll of honorary members (page vi) includes 19 names, and 226 persons (Vol. X., p. xii) have been elected to corresponding membership.

OFFICERS AND MANAGEMENT.

The officers, who are chosen from the active members, consist of a President, two Vice-Presidents, Recording and Corresponding Secretaries, Treasurer, Librarian, three Curators and two Directors. The general business management of the Academy is vested in a Council composed of the officers.

The office of President has been filled by the following well-known citizens of St. Louis, nearly all of whom have been eminent in some line of scientific work: George Engelmann, Benjamin F. Shumard, Adolphus Wislizenus, Hiram A. Prout, John B. Johnson, James B. Eads, Wil-

liam T. Harris, Charles V. Riley, Francis E. Nipher, Henry S. Pritchett, John Green, Melvin L. Gray, Edmund A. Engler, Robert Moore, Henry W. Eliot, Edwin Harrison, Adolf Alt and Calvin M. Woodward.

MEETINGS.

The regular meetings of the Academy are held at its building, 3817 Olive Street, at 8 o'clock, on the first and third Monday evenings of each month, a recess being taken between the meeting on the first Monday in June and the meeting on the third Monday in October. These meetings, to which interested persons are always welcome, are devoted in part to the reading of technical papers designed for publication in the Academy's Transactions, and in part to the presentation of more popular abstracts of recent investigation or progress. From time to time public lectures, calculated to interest a larger audience, are provided for in some suitable hall.

The following dates for regular meetings for the year 1910 have been fixed by the Council:

Jan	Feb	Mar	April	May	June	Oct	Nov	Dec
3	7	7	4	2	6		7	5
17	21	21	18	16		17	21	19

LIBRARY.

After its organization, the Academy met in Pope's Medical College, where a creditable beginning had been made toward the formation of a museum and library, until May, 1869, when the building and museum were destroyed by fire, the library being saved. The library now contains about 18,500 books and 16,000 pamphlets, and is open during certain hours of the day for consultation by members and persons engaged in scientific work.

PUBLICATIONS AND EXCHANGES.

Eighteen octavo volumes of Transactions have been published since the organization of the Academy, and widely distributed. Two quarto publications have also been issued: one from the Archaeological Section, being a contribution to the archaeology of Missouri, and the other a report of the observations made by the Washington University Eclipse Party of 1889. The Academy now stands in exchange relations with 586 institutions or organizations of aims similar to its own.

MUSEUM.

After the loss of its first museum, in 1869, the Academy lacked adequate room for the arrangement of a public museum, and, although small museum accessions were received and cared for, its main effort, of necessity, was concentrated on the holding of meetings, the formation of a library, the publication of worthy scientific matter, and the maintenance of relations with other scientific bodies.

The Museum is at present located on the third floor of the Academy Building and has in it a number of specimens illustrating the various branches of natural science, among which may be mentioned the Yandell Collection of fossils, a collection of some 600 exotic butterflies, a collection of Mound Builder pottery and skulls from near New Madrid, Mo., and a collection of 25 meteorites. Our material forms but a nucleus of a museum which the Academy hopes to establish—a museum which we trust will be of benefit to the public and to the educational institutions of the city.

RECORD.

From January 1, 1908, to December 31, 1909.

The following list of papers were presented at the meetings during this period:

January 6, 1908:

G. O. James.—Approximate Determination of Latitude.

January 20, 1908:

C. B. Curtis.—The Planet Mars.

February 3, 1908:

C. H. Neilson.—Eosinophilia and Indicanuria.

February 17, 1908:

Gustav Cramer.—Color Photography.

March 2, 1908:

J. A. Drushel.—Glacial Drift under the St. Louis Loess.
(Published in Journal of Geology, Vol. XVI, 1908.)

March 16, 1908:

C. C. Guthrie.—Transplantation of Ovaries in Chickens.

April 6, 1908:

LeRoy McMaster.—Radioactivity.
(Published in Washington University Bulletin, Series II., Vol. VIII., No. IV., 1910.)

April 20, 1908:

A. C. Eycleshymer.—Growing Old, and the Attempts to Prevent It.

May 4, 1908:

H. A. Wheeler.—The Occurrence of Oil and Gas about St. Louis.

May 18, 1908:

LINDLEY PYLE.—Measurement of the Acceleration of a Freely Falling Body.

June 1, 1908:

S. A. DOUGLASS.—The Electric Furnace in Industrial Chemistry.

October 19, 1908:

A. S. LANGSDORF.—Fatigue of Insulation.
(Published in Electrical World, Vol. LII., Oct., 1908.)

November 2, 1908:

H. M. WHELPLEY.—Cranial Surgery among the Primitive Races.

November 16, 1908:

E. J. SWIFT.—How We Learn to Do Things.
(Published in "Mind in the Making," Scribners, 1908.)

December 21, 1908:

J. N. BASKETT.—Heads and Tails in Nature.

January 4, 1909:

C. A. WALDO.—What a Volcano is Doing.

January 18, 1909:

WM. H. ROEVER.—Optical Interpretation of Some Problems in Statics.

February 1, 1909:

GUSTAV BAUMGARTEN.—The Personality of Engelmann.

H. A. WHEELER.—Engelmann's Contribution to Geognosy.

F. E. NIPHER.—Engelmann's Work in Meteorology.

WM. TRELEASE.—Engelmann as a Biologist.

February 15, 1909:

S. M. COULTER.—Darwin as a Naturalist.

W. E. MCCOURT.—Darwin's Influence upon Geology.

J. F. ABBOTT.—The Natural Selection Theory and Its Latter Day Critics.

A. O. Lovejoy.—Some Aspects of Darwin's Influence upon Modern Thought.

(All published in Washington University Bulletin, Series II., Vol. II., No. III., 1909.)

F. E. Nipher.—Momentum Effects in Electrical Discharge.

March 1, 1909:

Julius Hurter.—The Amphibians and Reptiles of Arkansas. By Julius Hurter and John K. Strecker, Jr.

(Published in the Transactions, Vol. XVIII, No. 2.)

Julius Hurter.—The Blind Salamanders of the World.

March 15, 1909:

Otto Widmann.—The Birds of the Missouri Botanical Garden.

(Published in the Twentieth Report of the Missouri Botanical Garden, 1909.)

April 5, 1909:

W. H. Chenery.—The Relation of the Physiography of the Iberian Peninsula to the Development of the Spanish and Portuguese Peoples.

April 19, 1909:

R. J. Terry.—An Observation on the Development of the Mammalian Vomer.

(Published in Anatomical Record, Vol. III., No. 10, 1909.)

Joseph Grindon.—The Protection against Disease Afforded by Certain Substances in the Blood.

May 3, 1909:

Wm. Trelease.—The Mexican Fiber Agaves known as Zapupe.

(Published in the Transactions, Vol. XVIII., No. 3.)

May 17, 1909:

W. E. McCourt.—Diamonds in Arkansas.

(Published in Washington University Record, Vol. V, No. II., 1910.)

F. E. Nipher.—Electrical Discharge.

June 7, 1909:

W. E. McCourt.—The Onondago Cave.

F. E. Nipher.—Electrical Discharge.

October 18, 1909:

R. J. Wallace.—The Physical Possibilities and Limitations of "Autochron" Color Photography.

November 1, 1909:

A. S. Langsdorf.—Lightning and Lightning Protection.

November 15, 1909:

J. J. Kessler.—Metals and Alloys under the Microscope.

December 6, 1909:

R. R. Gates.—The Cytological Aspect of Evolution by Mutation.

December 20, 1909:

V. E. Emmel.—Observations on the Differentiation of Regenerating Epidermal and Striated Muscle Tissue.

F. E. Nipher.—Electrical Discharge.

(Published in the Transactions, Vol. XIX., No. 1, 1910.)

Meeting of January 6, 1908.

The Academy of Science of St. Louis met in the Academy Building, 3817 Olive Street, at 8 p. m., January 6, 1908; President Woodward in the chair; attendance 16.

The President delivered his address as President of the Academy for the year 1907.[4]

The Treasurer's report for the year 1907 was submitted.[5]

The report of the Curators for 1907 was read.[6]

The report of the Librarian for 1907 was presented.[7]

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[4]Transactions, Vol. XVII, page li.

[5]Transactions, Vol. XVII, page liv. (Incorporated in President's Report.)

[6]Transactions, Vol. XVII, page lix.

[7]Transactions, Vol. XVII, page lvi.

The Nominating Committee reported the results of the election of officers for 1908 as follows:

President	C. M. Woodward.
First Vice-President	Arthur Thacher.
Second Vice-President	Launcelot W. Andrews.
Recording Secretary	Samuel M. Coulter.
Corresponding Secretary	H. August Hunicke.
Treasurer	Charles D. Stevens.
Librarian	Mary J. Klem.
Curators	Frank Schwarz.
	Julius Hurter.
	Mary J. Klem.
Directors	Francis E. Nipher.
	Otto Widmann.

Dr. G. O. James presented a paper on "The Approximate Determination of Latitude."

The following were elected to membership: Charles Ammermann, Clarence I. Browne, Francis E. Cook, Samuel M. Coulter, Samuel Cupples, Chester B. Curtis, S. A. Douglass, E. O. Greer, W. D. Higdon, Carl I. Ingerson, G. O. James, N. L. T. Nelson, Lindley Pyle, C. G. Rathmann, C. F. Redlich, Edwin Schisler, William E. Shahan.

JANUARY 20, 1908.

President Woodward in the chair; attendance 110.

Mr. Chester B. Curtis delivered an address on "The Planet Mars."

The following were elected to membership: O. F. Ball, J. N. Baskett, C. J. Borgmeyer, W. M. Butler, J. A. Drushel, E. J. Ericson, J. J. Kessler, Geo. Lang, Jr., E. H. Larkin, G. B. Morrison, Henry Nicolaus, H. W. Scheffer, Leo. Suppan.

FEBRUARY 3, 1908.

President Woodward in the chair; attendance 11.

A letter was read from the Carnegie Institute of Pittsburg, presenting to the Academy a copy of the memorial of the Celebration of the Carnegie Institute in 1907.

A number of mineralogical specimens from Arizona were presented to the Academy by Mr. Julius Hurter.

Dr. C. H. Neilson presented the results of his recent work on Eosinophilia and Indicanuria.

Mr. W. A. Brandenburger was elected to membership.

February 17, 1908.

President Woodward in the chair; attendance 45.

Mr. Gustav Cramer presented a paper on "Color Photography," explaining and illustrating the various processes.

March 2, 1908.

President Woodward in the chair; attendance 26.

Mr. J. A. Drushel presented a paper on "The Glacial Drift under the St. Louis Loess." The speaker maintained that the ice sheet covered the site of St. Louis, as evidenced by the wide distribution of boulder clay and pebbles. The paper was illustrated with lantern slides and a number of pebbles were exhibited. These specimens had been collected from deposits in various parts of the city.

Professor Trelease presented by title a paper by Professor C. S. Sargent, of the Arnold Arboretum on "Crataegus in Missouri," and offered a brief abstract of it.

Mr. Darling Kennett Greger was elected to membership.

March 16, 1908.

President Woodward in the chair; attendance 14.

Dr. C. C. Guthrie presented an illustrated paper on "Transplantation of Ovaries in Chickens."

April 6, 1908.

Vice-President Andrews in the chair; attendance 29.

A collection of 47 Crinoids comprising 20 species from Crawfordsville, Ind., was presented to the Academy by Mr. Frank Springer, of Burlington, Iowa.

Dr. LeRoy McMaster presented a paper on "Radioactivity."

Mr. Frank Springer was elected to honorary membership.

The death of Mr. F. Louis Soldan was reported.

April 20, 1908.

President Woodward in the chair; attendance 32.

The President spoke at length of the bill now pending before Congress to establish a permanent national bison range near Wichita, Kansas. Upon motion the Secretary was instructed to write the Representatives of Missouri urging the importance of prompt action upon the bill.

Dr. A. C. Eycleshymer read a paper on "Growing Old, and the Attempts to Prevent it." After giving a brief resumé of the common theories on how to live to an old age, Dr. Eycleshymer discussed what modern science has learned about the physiological changes which produce senile decay. He demonstrated that the disproportionate growth between the protoplasm and the nuclear cells of the body is responsible for the degeneration of tissue, resulting in old age and death. While nature itself is able to arrest this process, as for instance, when muscular tissue is wounded, science has not succeeded in accomplishing this restoration. While eventually mental and physical pain will be eliminated, we will always be baffled in the end by death.

In conclusion the speaker said that, after all, the great work of medical science lay not in overcoming old age, but in increasing the average age, in combating disease and staying the hand of death in this form. Here medical science had demonstrated its strength and given a foresight of its possibilities. From this standpoint Dr. Eycleshymer made an appeal for the establishment in St. Louis of an institution for the study of the causation and prevention of disease along the lines of the Rockefeller Institute in New York, the McCormick Institute in Chicago, and the Phipps Institute in Philadelphia.

May 4, 1908.

Vice-President Andrews in the chair; attendance 46.

Mr. H. A. Wheeler presented a paper on "The Occurrence of Oil and Gas about St. Louis."

The great industrial advantages of natural gas and the still greater civic benefits that would result from eliminating the smoke and soot produced by our bituminous coal have made its possible occurrence of great importance to St. Louis. It induced a syndicate of one hundred leading manufacturers about 1887 to retain Prof. W. B. Potter to investigate the possibilities of finding natural gas in the vicinity of St. Louis. After he reported unfavorably, they authorized him to conduct extensive tests on making producer gas at the adjoining Illinois coal mines and piping it to St. Louis. Ten carloads of local coal were forwarded to Pittsburg to test in various gas producers and while the results were satisfactory, the fuel gas could not compete with the low prices of coal that rule in the St. Louis market. Subsequently Prof. I. C. White, the oil specialist, was also retained and on his recommendation two test wells were drilled to the Trenton limestone (the gas horizon of Indiana). One well at Edwardsville, Ill., twenty miles northeast of St. Louis, was 2300 feet deep, and the other, at Marshall, Mo., seven miles west of St. Louis on the Manchester road, was 1800 feet deep. As both were unsuccessful, the syndicate abandoned further work.

The numerous wells that have been drilled for water (estimated at 200) about St. Louis, have added a large amount of unfavorable evidence until the Welle-Boettler well recently tapped some gas and oil. The wells usually range from 400 to 900 feet in depth, although the Belcher well near the river at 210 O'Fallon street, drilled in 1854, is 2199 feet, and the famous well at the Insane Asylum, at Arsenal and Macklind avenue, is 3843½ feet deep. Fresh, potable waters that are rather high in carbonate of lime and magnesia are usually found above 700 feet, while below that horizon they are more or less saline. At about 1500 feet, a "sulphur water" occurs that contains small amounts of sulphuretted hydrogen, as at the Belcher well.

At a well drilled in 1888 at the Grone brewery, 2207 Clark avenue, a heavy, dark petroleum was noticed at 712 feet, but, as the amount was trifling, it attracted no attention.

In drilling for water at the Welle-Boettler bakery at 3905 Forest Park boulevard, in 1904, gas and oil were struck at 620 feet, which fact created some excitement and stimulated the drilling of ten wells the following year in that neighborhood. The No. 1 Welle-Boettler well showed a gas pressure of about 250 pounds when closed in and furnished sufficient gas to operate three bake ovens. It also yielded several barrels of heavy, black oil of great viscosity. A second well 100 feet north, that was 700 feet deep, gave small amounts of oil and gas, a third 900 foot well, 100 feet west, was barren, and a fourth well 400 feet deep, located about 75 feet northeast of No. 1, gave a trifling amount of oil.

The following is the log of the Welle-Boettler well as given to the U. S. Geological Survey by the driller and the oil and gas shale at 600 to 620 feet, was regarded as of Devonian age.

LOG OF THE WELLE-BOETTLER WELL.

Filled ground	0— 20 feet
Clay	20— 40 feet
Sand and gravel	40— 60 feet
Hard gray limestone (shaly); a little water	60— 80 feet
Soft brown limestone	80—100 feet
Hard brown limestone	100—120 feet
Soft gray limestone; water at 140-160 and 185-240	120—240 feet
Soft gray shale	240—260 feet
Hard gray limestone	260—265 feet
Soft gray limestone and shale	265—280 feet
Gray limestone; show of oil 280-290 and 305-325	280—460 feet
Very hard gray limestone and chert	460—470 feet
Hard gray limestone	470—485 feet
Soft gray limestone	485—490 feet
Hard gray limestone	490—510 feet
Soft dark red shale, oil showing	510—530 feet
Hard gray limestone	530—565 feet
Hard gray limestone and shale-caves	565—600 feet
Soft black shale, little oil	600—620 feet
Soft brown limestone, little oil and gas	620—650 feet

On the Drummond lot at 3904 Forest Park boulevard a test well was drilled about 700 feet deep. This was 250 feet southeast of the Welle-Boettler wells; another test well was drilled on the east side of Vandeventer avenue, about 400 feet farther southeast, but both were barren.

At the Tamm glue factory, Manchester and Wabash R. R., two tests were drilled, one of which yielded a little gas at 505 feet and more at 760 feet and which showed a pressure of 42 pounds when shut in. The amount was not encouraging, however, and the well is now full of salt water.

From samples of the drillings placed at my disposal by Mr. Tamm, the following tentative log of his gas or No. 9[*] well is herewith submitted.

LOG OF THE TAMM WELL.

Surface clays	0— 25 feet
Limestone, gray	25—100 feet
Limestone, gray, cherty	100—125 feet
Limestone, gray	125—175 feet
Shale, blue	175—220 feet
Limestone, gray	220—440 feet

[*]There are several shallow water wells on the premises.

Shale, green	440—495 feet
Shale, brown, sandy	495—505 feet
Limestone	505—530 feet
Shale, dark	530—540 feet
Shale, sandy	540—575 feet
Limestone (?)	575—610 feet
Shale, green	610—680 feet
Shale, black (Devonian)	680—710 feet
?	710—765 feet

First gas found at 505 (under the brown shale) and more gas at 760 feet with a little heavy, black oil; salt water occurs at 550 feet and sulphur water at 764, this overflows in a small quantity; hole is 8 inches in diameter and cased to 600 feet; tools are now stuck at bottom of hole.

At the Fruin & Bambrick quarries, at Spring and Chouteau avenues, two tests were drilled that yielded a little gas at 470 and 560 feet and considerable at 720 feet. A tank 30 feet in diameter was erected to store the gas and pumps were installed to remove the salt water which interfered with the gas. The west well is said to have produced 6000 cubic feet of gas per day and to show a pressure of 90 pounds when shut in, but the corrosive action of the water on the pumps has made it difficult to maintain them.

Both wells are now full of water, although the owners hope to recover them. The quarry face shows that these wells are on a small, gentle anticline that has a northwesterly trend and on which undoubtedly occur the Tamm and Welle-Boettler wells. It also explains why the amount of gas and oil is so discouraging in the area drilled, which is about 2000 feet long by 500 feet wide. These wells inspired a prolific crop of fakers, who for trifling fees claimed to be able to locate "gas veins," "oil lakes" or metallic ores by the use of divining rods, silk-covered canes and mysterious little boxes that "unerringly by scientific principles" would give the size, depth and richness of the underlying "buried wealth."

The recent discovery of the rich oil fields of Eastern Illinois has again stimulated prospecting about St. Louis. Test wells have recently been drilled 1500 feet deep at Glencoe, about 1500 feet at Manchester and 1080 feet at Ranken, in the western part of St. Louis County. As they started at or about the outcrop of the Trenton limestone, it would have been very remarkable had they proved otherwise than "dusters" or barren, as the geological conditions below that horizon are not favorable.

A shallow test was drilled in the outcrop of the Trenton limestone near Antonio, about twenty-two miles southwest of St. Louis, on the strength of the "oil-rock" or thin brown oily shale that occurs at the top of the Trenton. As splinters of this shale burn with a strong empyreumatic odor, it has misled many to believe that a paying oil pool occurs in the vicinity. As this thin oily shale caps the Trenton as far north as Wisconsin, and thus underlies a large part of the Mississippi Valley, it is liable in the future to deceive others by the

"oil showing" it makes when penetrated by the drill. If structural and other important geological conditions are favorable, however, the Trenton limestone is likely to be as important an oil producer in this territory.

As the thin Coal Measures, the thick Sub-carboniferous, the thin Devonian and the thick Silurian formations that underlie St. Louis rise rapidly[9] and outcrop to the west, the place to expect paying pools of oil and gas is to the east of St. Louis, in Illinois, where the strata flatten to a dip of ten feet per mile, where there are several anticlinels, and where there are at least three different formations that are favorable for the occurrence of oil and gas in profitable quantities. For Illinois has from 600 to 1400 feet of Coal Measures which contain several thick sandstones with heavy shale caps that are favorable for oil reservoirs, and in which occur the oil pools of the eastern side of the state. At 600 to 800 feet below the Coal Measures occurs a black Devonian shale, beneath which an excellent grade of oil, 42° B. gravity, has recently been discovered at Peters, ten miles northeast of St. Louis. This horizon has seldom been tested in Illinois, as thus far the drilling has been mainly confined to the shallow Coal Measures.

The Trenton and Galena formations underlie almost the entire state of Illinois and where they outcrop in the northwest corner of the state they consist of heavy, shale-capped limestones that are more or less magnesian, and, therefore, in a favorable condition for acting as a reservoir for oil. As they lie at a depth of 1500 to more than 2500 feet over most of the state, they are not likely to be tested until the upper sands have been exhausted.

The structural conditions of Illinois are very favorable for oil and gas, as the state essentially consists of a large, simple basin, whose axis runs through the central portion of the state with a north-northwesterly trend. In fact, it is surprising that oil men have ignored the state until lately, as the conditions are most encouraging for the occurrence of oil and gas on both the eastern and western flanks of the basin. There is an abundance of material for forming, storing and protecting oil and gas and ideal conditions for its concentration into paying pools. A little oil and gas was found forty years ago at a depth of 400 feet at Casey, on the eastern flank of the basin, but the oil pools, that now exceed 80 in number and have been developed in six eastern counties, have all been discovered within the past three years. Since the eastern flank of the basin is being literally drilled, the oil men are beginning to give their attention to the western flank of the basin, where the conditions are fully as favorable.

Prospecting on a limited scale has been started in several places and the edges of four oil pools have been located at Litchfield and Butler, in Montgomery County (fifty to sixty miles northeast of St. Louis), at Peters, in Madison County (ten miles northeast of St.

[9] The saccharoidal or St. Peters sandstone, which is 1452 to 1585 feet deep in the Insane Asylum well, outcrops in the Meramec Valley, twenty-four miles southwest of this well, showing an average dip of about 60 feet per mile to the northeast.

Louis), and at Sparta, in Randolph County (fifty miles southeast of St. Louis).

Much of this prospecting has been done in a genuine wild-cat or hit-or-miss manner, in which little or no judgment or geological study have been displayed and without any relation to anticlinal or other favorable conditions. One hole has also been the usual limit of a test, so that the evidence has been largely wasted, even if correctly interpreted. When the drill has been as extensively employed on the western flank of the basin as it has been in the past three years in eastern Illinois, the output of oil and gas is likely to be as large as in this rich field. Since the distance of the Western Illinois field from St. Louis ranges only from ten to seventy miles, its development is of the greatest importance to St. Louis financial and civic interests, especially if it should duplicate the very profitable record of the Eastern Illinois field in growing from a production of 160,000 barrels in 1905 to 25,000,000 in 1907.[10]

May 18, 1908.

President Woodward in the chair; attendance 15.

The librarian reported the receipt of twenty-one volumes of the first series of Transactions and ten volumes of the first series of Proceedings of the Royal Irish Academy as a gift to the library; also the receipt of the early volumes of the Proceedings of the Natural History Society of Zürich.

Professor C. M. Woodward presented to the museum some specimens of copper from Calumet, Mich., taken from the native rock at a depth of 4600 feet in mine No. 3, Tamarack Mine.

Mr. Lindley Pyle presented a paper entieled "Measurement of the Acceleration of a Freely Falling Body."

June 1, 1908.

President Woodward in the chair; attendance 20.

The Librarian reported the gift to the Academy library of twenty volumes of the Proceedings of the American Association for the Advancement of Science and ten volumes of "Naturwissenschaftliche Rundschau" from Dr. Evers.

In the matter of securing the co-operation of all scien-

[10] The production of the Eastern Illinois oil fields in 1908 from about 12,000 wells, ranging from 400 to 1600 feet in depth, was 38,844,899 barrels, which breaks all records in the history of the industry for such a phenomenal output in only four years of development.

tific organizations in the city in improving their library facilities, the Librarian reported as follows:—

In response to an invitation from the President of the Academy of Science of St. Louis to a conference to discuss the library facilities of the various scientific institutions of the city the following representatives met at the Academy Building, Wednesday evening, May 27, 1908:

Engineers' Club of St. Louis	A. S. Langsdorf
Entomological Club	Herman Schwarz
Missouri Botanical Garden	William Trelease
St. Louis Chemical Society	H. August Hunicke
St. Louis University	J. P. Coony
	F. Siedenburg
Washington University	A. S. Langsdorf
Academy of Science of St. Louis	Mary J. Klem

The meeting organized by electing Professor Trelease chairman and Miss Klem secretary.

The Chairman called on Miss Klem to state on behalf of the Academy the object of the meeting. Miss Klem explained that in many instances societies were duplicating each other's libraries, while many valuable and desirable scientific publications were wanting in all. Much could be accomplished toward improving library facilities by the co-operation of all the organizations; thereby avoiding useless duplication and building up the various libraries systematically. Miss Klem also stated that each institution was to retain complete control of its own library, but to extend its use under such restrictions as may seem proper to the members of any of the other organizations.

After the delegates present had expressed the views of the organizations which they represented, ways and means of improving existing conditions were discussed. The consensus of opinion was that, before any steps could be taken toward revising the exchange list of the Academy and the subscription lists of the other organizations, the present facilities would have to be definitely known. Accordingly, Mr. Hunicke moved that the Chairman appoint a committee to prepare a catalogue of the serial publications in the physical sciences in the various libraries in the city as a complement to the catalogue of biological serials prepared under the direction of the Missouri Botanical Garden. This motion, seconded by Prof. Langsdorf, was carried. Before the close of the meeting the Chairman appointed Mr. Hunicke, Prof. Langsdorf and Miss Klem as such a committee.

It was also decided to ask the Mercantile and Public Libraries, the medical societies and any other scientific bodies which were not represented at the meeting, to assist in the preparation of the catalogue.

After the hearty support of the delegates present had been promised, the meeting adjourned subject to the call of the committee appointed by the Chairman.

(Signed) Mary J. Klem,
Secretary.

Mr. S. A. Douglass presented a paper on "The Electric Furnace in Industrial Chemistry."

Professor F. E. Nipher spoke at some length of the velocity and momentum of an electric current and exhibited a number of lantern slides illustrating his subject.

October 19, 1908.

President Woodward in the chair; attendance 20.

The Librarian reported the following gifts:—

Three pictures of Lord Kelvin from the Royal Society, London; four pictures of western scenery from Dr. G. Hambach; six volumes from Mr. E. P. Olshausen; 105 volumes from various societies to complete sets in the library.

Miss Klem, secretary of the Library Committee, then read the following report:—

The second meeting of the representatives of the various libraries of the city was held at the Academy Building, 3817 Olive street, Tuesday evening, October 13, 1908.

The following were present:

Biological Society	R. J. Terry
Engineers' Club of St. Louis	A. S. Langsdorf
Mercantile Library	W. L. R. Gifford
Missouri Botanical Garden	William Trelease
Public Library	Miss Wagner
St. Louis University	John P. Coony
	James P. Monaghan
Snodgras Laboratory	D. L. Harris
Washington University	A. S. Langsdorf
Academy of Science	Mary J. Klem

Professor A. S. Langsdorf read the following report of the committee appointed at the previous meeting, which, upon motion duly seconded, was accepted:

October 13, 1908.

The committee appointed to prepare a catalogue of the serial publications in the various libraries in the city, beg to submit the following report:

During the summer the scientific serials in the following libraries have been listed:

Academy of Science of St. Louis, Engineers' Club of St. Louis, Mercantile Library, Missouri Botanical Garden, Public Library, St. Louis Chemical Society, St. Louis Medical Library, St. Louis University, St. Louis University Medical Department, Snodgras Labora-

tory, Washington University, Washington University Medical Department.

While many valuable series were found in the course of the investigation, we found that in most cases the series were broken. We would recommend that, if possible, the library having scattered volumes of any journal turn these over to the library having the more nearly complete set of that publication.

We also found that while certain publications were represented by more or less complete sets in all the libraries, other very important journals were wanting entirely or represented only by a few scattered volumes.

Frequently it was found a rather difficult matter to decide whether certain publications should or should not be included. For instance, the close relation between archæology and history makes it at times almost impossible to decide which historical publications shall be rejected and which shall be retained, as a large number of historical and antiquarian societies and magazines discuss archæological material relating to prehistoric periods. The question also arises whether economics shall be included as a science.

In conclusion we beg to submit the following recommendations:

1st. That another sub-committee be appointed whose duty it shall be to draw up an estimate of the cost of publishing the catalogue, and to make a canvass of the various libraries and societies of the city for the purpose of raising the necessary funds.

2nd. That all serial publications be included.

3rd. Where possible, libraries having scattered volumes turn these over to the library having the more nearly complete sets of those publications. It would be desirable to have this done before the publication of the catalogue.

4th. That the exchange or subscription lists of the societies be revised.

Respectfully submitted,

(Signed) H. Aug. Hunicke,
Chairman.

These recommendations were adopted.

Mr. Gifford, Father Monaghan and Miss Klem were appointed as such a sub-committee.

(Signed) Mary J. Klem,
Secretary.

Professor A. S. Langsdorf presented a paper on "The Fatigue of Insulation."

The President appointed a committee to investigate the possibilities of a better conservation of the natural resources of Missouri.

The death of Mr. George S. Drake was reported.

NOVEMBER 2, 1908.

President Woodward in the chair; attendance 28.

Dr. H. M. Whelpley presented a paper on "Cranial Surgery among the Primitive Races."

The following were elected to membership:

C. E. Caspari, C. A. Dieckmann, R. C. Lange, F. Malkmus, W. W. Schmidt, L. W. Schnell, Ernest Schwarz, Herman Schwarz, Adolf Wilkus.

NOVEMBER 16, 1908.

President Woodward in the chair; attendance 26.

Professor Edgar James Swift presented a paper on "How We Learn to Do Things."

Mr. William K. Ilhardt was elected to membership.

DECEMBER 7, 1908.

Vice-President Andrews in the chair; attendance 10.

Dr. Ulrich Harder was elected to membership.

Dr. D. S. H. Smith, Dr. R. J. Terry and Professor A. S. Langsdorf were elected to serve as a committee to nominate officers for the year 1909.

DECEMBER 21, 1908.

President Woodward in the chair; attendance 24.

The Secretary read the following report of the committee appointed to nominate officers for 1909:

St. Louis, Mo., December 18, 1908.

To the Members of the Academy of Science of St. Louis:

Gentlemen—Your Nominating Committee begs to submit the following list of nominations for officers for the ensuing year:

President	William Trelease
First Vice-President	Arthur Thacher
Second Vice-President	L. W. Andrews
Recording Secretary	W. E. McCourt
Corresponding Secretary	H. A. Hunicke
Treasurer	Charles D. Stevens
Librarian	Mary J. Klem
Curators	Julius Hurter
	Otto Widmann
	Joseph Grindon
Directors	F. E. Nipher
	C. B. Curtis

Respectfully submitted,

(Signed) D. S. H. SMITH, Chairman,
R. J. TERRY,
A. S. LANGSDORF.

A petition of nine members of the Academy that the creation of an Entomological Section be authorized, was read and such a section approved.

Mr. James Newton Baskett presented a paper on "Heads and Tails in Nature."

The death of Mr. Francis D. Hirschberg was reported.

REPORTS OF OFFICERS.

President's Report.

The year 1908, the fifty-third year of the Academy's existence, has been relatively uneventful. The legitimate work of the Academy has gone on without interruption; valuable papers have been read, and our library of exchange proceedings has grown steadily; our building and grounds have been kept in order; and no great calamity has fallen upon us. For detailed reports I beg to refer to the reports of the various officers.

We have had sixteen regular meetings with the following list of papers and discussions:

Approximate Determination of Latitude—G. O. James.[11]
Planet Mars—C. B. Curtis.[11]
Eosinophilia and Indicanuria—C. H. Neilson.
Color Photography—G. Cramer[11]
Glacial Drift under the St. Louis Loess—J. A. Drushell.[11]
Transplantation of Ovaries in Chickens—C. C. Guthrie.
Radioactivity—L. McMaster.
Growing Old, and the Attempts to Prevent it—A. C. Eycleshymer."
Oil and Gas in St. Louis and Vicinity—H. A. Wheeler.[11]
Measurement of the Acceleration of a Freely Falling Body—L. Pyle.[11]
Electric Furnace in Industrial Chemistry—S. A. Douglass.[11]
Momentum Effects of an Electric Discharge—F. E. Nipher.[11]
Fatigue of Insulation—A. S. Langsdorf.[11]
Cranial Surgery among the Primitive Races—H. M. Whelpley.[11]
How We Learn to Do Things—E. J. Swift.
Heads and Tails in Nature—J. N. Baskett.[11]

Our attendance record has preserved the even tenor of last year.

Total attendance 1908	472	
Average attendance 1908	30	
Smallest attendance	10	Dec. 7
Largest attendance	110	Jan. 20
Total attendance 1907	482	
Average attendance 1907	30	

[11] Member.

There has been a small gain in our membership, though three valuable members died during the year, and a few found it necessary to resign. For the sake of comparison, the membership from 1907 and for 1908 is given.

	1907	1908
Patrons	3	3
Honorary Members	11	12
Corresponding Members	122	122
Life Members	1	1
Active Members	..	..
Resident	191	220
Non-resident	46	45
	374	403

	Honorary.	Resident	Non-Resident.
Elected	1[12]	41	2
Died	..	3[13]	..
Resigned	..	7	3
Transferred	..	2	1
Dropped	..	1	1

By a concerted effort on the part of the active members a similar gain in membership may be made every year. Interest in science, pure and applied, was never so great as now, and zeal for research in new fields, and for the utilization of what has been discovered in old fields, is on the increase. Moreover, if one is not a scientist, he may have faith in the value of scientific culture and may be glad to promote the work of an Academy like ours.

The following statements are compiled from the report of the Treasurer and from the records of Council Proceedings:

CASH RECEIPTS 1908.

On hand January 1, 1908	$ 74.02
Collection of rents	669.75
From members, dues and initiation fees	1,208.00
Interest on mortgage and deposits	184.58
Certificate of deposit	1,000.00
For telephone	10.00
Total receipts	$3,146.35

[12] Mr. Frank Springer, Burlington, Iowa.

[13] Mr. F. Louis Soldan, Mr. Geo. S. Drake, Mr. F. D. Hirschberg.

DISBURSEMENTS.

General expenses	$ 476.38
Current expenses	120.00
Printing transactions	267.79
Employees	1,100.00
Note	389.55
Balance on hand December 31, 1908	792.63
	$3,146.35

The above report suggests several things to the careful reader. There is a regrettable laxity in the payment of dues. The annual dues for resident members is $6.00, and for non-residents, $3.00. Hence the income from fees alone should have been $1,320.00 plus $90.00, making $1,410.00, which is $202.00 more than the Treasurer's Report shows. Had all the dues been paid, including back dues long unpaid, we should have been able not only to pay an overdue bill of $389.55 for printing a scientific paper in 1907, but we could have printed several papers submitted for publication during 1908. As it was, but a single short paper of ten pages was printed and distributed throughout the wide circle of our exchanges, some 585 in number.[14]

We are fortunate in our tenants who use rooms we are able to spare permanently or the Lecture Hall on specified evenings when not needed by the Academy. So great is our need of income for the purpose of publishing papers, that we are willing and even desirous of renting a fine first floor room, with the occasional use of the lecture hall, at the present time. The room is heated, lighted, and cleaned, and in every way suited for a club or league of scientific, literary or artistic character.

Our fixed charges are relatively large. The monthly pay roll is $100.00, and the incidentals for printing, postage, fuel, repairs, etc., carry the total fixed charges for the year up to $1,800.

An estimate can now be made of the possible amount of money available for printing and distributing scientific papers in 1909 on the basis of present membership, tenants and endowment, as follows:

Annual dues (possible)	$1,500.00
From tenants	650.00
From $3,000 mortgage	180.00
From $1,000 certificate of deposit	40.00
	$2,370.00

[14] C. M. Woodward—Air-Ship Propeller Problems. Vol. XVIII, No. 1.

Pay roll	$1,200.00
Fuel, light	315.00
Printing and postage for notices of meetings, etc	150.00
Repairs	75.00
Telephone	48.00
Miscellaneous	150.00
	$1,938.00
Residue for publishing papers	$ 432.00

The retiring President wishes he could say that the above estimate is reasonable; but he fears that some of the annual dues may not be paid, and that the items of "Repairs" and "Miscellaneous" may be unexpectedly greater. It is quite certain that the front steps need repairs, if not entire reconstruction. If, however, the spare room could be well rented, the writer believes the residue for publications would be realized.

In his report a year ago, the writer discussed a plan for the erection of a fireproof building on the rear of the Academy lot for the accommodation of the Library, Museum, Council Room and Lecture Hall, while renting the entire present building for commercial purposes, the income of which should go wholly to promote the legitimate work of the Academy. If money should be given the Academy —say $50,000.00—to carry out this plan several important results would follow:

1. First and foremost the Academy would be sure of an adequate income for all time. The commercial value of the present building, enlarged or reconstructed, would be permanently very great.

2. The Library and museum would be properly arranged and stored in a *fireproof* structure, reasonably secure from all injury. Words cannot properly describe the present jeopardy of our library of 20,000 scientific volumes and pamphlets standing exposed on wooden shelves in a building with wooden floors, doors and stairs, and with a large coal-burning furnace in the basement—in short, in a veritable "fire trap." The Academy cannot afford to insure the library and, besides, no reasonable amount of money would compensate for its loss. No friend of the Academy, certainly no President and Council, can look the present situation squarely in the face and not tremble at the thought of a conflagration in or near our building. Ten minutes of fire and water, and the priceless library is a ruin.

3. The plan under discussion includes a Hall for Lectures, built for the purpose, with a smooth white wall for lantern pictures, with seats arranged for seeing and hearing, and above all remote from the almost continuous rattling, rumbling, jangling, whirring, honking of trolley cars and automobiles, which infest our present hall.

The proposed new building should stand flush on the alley, forty or fifty feet from the present structure, and a few feet from the east and west boundaries of the lot, with a heating plant so placed as to economically heat both buildings, rear and front.

The opportunity to accomplish these three things: To lift the Academy to a plane of great efficiency in its work; to give our treasures absolute security; and to provide a lecture hall ample, convenient and quiet—is one which ought to appeal strongly to a man or a woman of means, who is in sympathy with our work. Mrs. William McMillan gave to the Academy the present building and lot—and that generous deed and gift to science should be recorded in imperishable bronze. A second tablet should record the noble act of a second benefactor who gives the means for realizing the vast benefits named above, and whose name will go down the ages as a patron of Science.

In place of the plan proposed above, it has been suggested that, if a benefactor or a group of benefactors, can be found to pledge the funds for erecting a new building similar to the one above described, the friends of the Academy should ask the City to give a site in Forest Park, say on Kingshighway, and then, with the consent of Mrs. McMillan sell the present property and invest the proceeds as a permanent endowment. Perhaps this latter plan is the best, when we look far into the future. It, however, involves a benefactor, a Friend of Science, and a benefaction from the city like that given to the Art Museum. In this splendid city with its intelligence, wealth and zeal for both Art and Science, the coming year should see the realization of one of these plans.

These suggestions are respectfully commended to the members and friends of the Academy.

(Signed) CALVIN MILTON WOODWARD,

President.

TREASURER'S REPORT.

The substance of the Treasurer's report is incorporated in the address of the President.

On January 1, 1908, the Treasurer had a cash balance of $74.02, a certificate of deposit of $1,000.00, and a mortgage amounting to $3,000.00. The income during the year amounted to $2,072.33, and the expenditures during the year amounted to $2,353.72, leaving at the close of the year 1908 a balance in the treasury of $792.63 in addition to the mortgage of $3,000.00.

LIBRARIAN'S REPORT.

The Librarian reported that accessions to the library for the year by exchange with 113 home societies and 239 foreign societies amounted to 615 volumes and 671 pamphlets, and from donations 105 volumes and 146 pamphlets, making a total in the library at present of 17,881 books and 16,218 pamphlets.

The transactions of the Academy for the year were sent to 161 home societies and 420 foreign societies.

During the year the following donations to the library were received:

Carnegie Museum, Pittsburg—Memorial volume of Celebration in 1907.

Dr. Edward Evers—20 volumes of the Proceedings of the American Association for the Advancement of Science, and 10 volumes of Naturwissenschaftliche Rundschau.

Professor A. S. Langsdorf—12 volumes of Science.

Mr. E. P. Olshausen—6 volumes of scientific books.

Dr. Enno Sander—Copies of Science and medical journals.

105 volumes and 124 numbers from various scientific societies to complete sets in the Academy library.

A minute of the meetings of the committee from the various scientific institutions in the city, appointed to devise some plan for more effective co-operation in the accumulation of scientific literature will be found in the Record. (Page xxxiii, xxxv).

Curator's Report.

The Curator reported the following gifts to the Museum:

Julius Hurter—Mineralogical specimens from the Petrified Forest of Arizona.

Frank Springer—47 crinoids comprising 20 specimens from Crawfordsville, Ind.

C. M. Woodward—Fine specimens of copper from Calumet, Mich., taken from native rock 4,600 feet down in mine No. 3, Tamarack Mine.

Mary J. Klem—Fossil wood from El Paso, Tex.

Royal Society of London—Three photo-engravings of the late Lord Kelvin.

G. Hambach—Four pictures of western scenery.

Report of the Entomological Section.

St. Louis, Jan. 4, 1909.

The Academy of Science of St. Louis:

Gentlemen—

I herewith beg leave to report that the Entomological Section of the Academy held its first regular meeting in the Academy Building Dec. 4, 1909. Professor J. F. Abbott was elected Chairman, and Mr. Herman Schwarz, Secretary, for the year 1909.

The consensus of opinion was that an effort must be made to secure for the museum a good collection of local insects, and in order to carry out this purpose, the section was divided into four parts, each to work in a specified group.

The question of proper receptacles for the collection was discussed and the Section entertains the hope that the Council will, at an early date, grant an amount of money sufficiently large to be used by the Section for the purpose of purchasing such cases.

The Section is at present composed of nine members and it is believed that this number will increase substantially in the near future.

The meetings will be held on the last Thursday evening of each month.

Respectfully submitted,

(Signed) HERMAN SCHWARZ,
Secretary.

JANUARY 4, 1909.

President Woodward in the chair; attendance 58.

Professor C. A. Waldo presented a paper on "What a Volcano Is Doing."

This being the annual meeting of the Academy, the reports of the President,[15] Treasurer,[16] Librarian,[17] and Curators[18] were submitted.

The report of the Entomological Section[19] was submitted.

The Nominating Committee reported the results of the election of officers for 1909, as follows:

President	William Trelease
First Vice-President	Arthur Thacher
Second Vice-President	L. W. Andrews
Recording Secretary	Walter E. McCourt
Corresponding Secretary	H. Aug. Hunicke
Treasurer	Charles D. Stevens
Librarian	Mary J. Klem,
Curators	Julius Hurter
	Otto Widmann
	Joseph Grindon
Directors	Francis E. Nipher
	Chester B. Curtis

Professor Woodward then introduced the President elect, Professor William Trelease, who spoke briefly regarding the opportunities for useful service in the Academy.

JANUARY 18, 1909.

President Trelease in the chair; attendance 25.

Professor William H. Roever presented a paper on "The Optical Interpretation of Some Problems in Statics."

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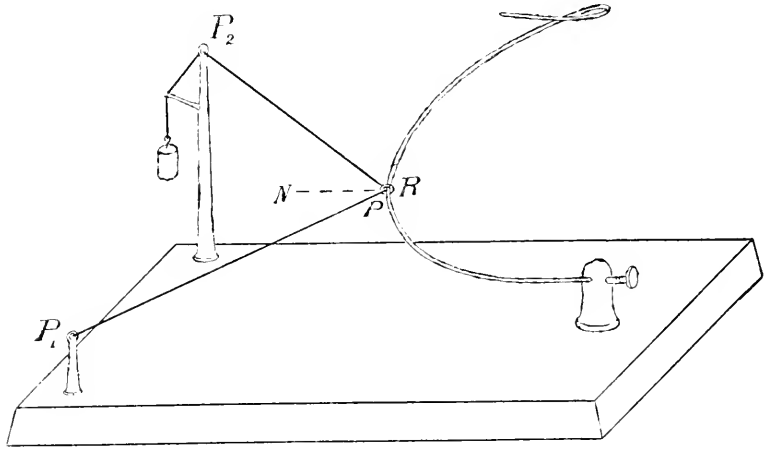
[15] Transactions, Vol. XVIII, page xxxviii.
[16] Transactions, Vol. XVIII, page xlii.
[17] Transactions, Vol. XVIII, page xlii.
[18] Transactions, Vol. XVIII, page xliii.
[19] Transactions, Vol. XVIII, page xliii.

Consider an apparatus consisting of a smooth wire and two small rings, P_1 and P_2, not on the wire, all rigidly attached to a frame. The wire is in the form of any curve (plane or twisted), and on it a small weightless ring R is capable of sliding without friction. A weightless and perfectly flexible string with a weight at one end, after passing through the rings P_2 and R, has its other end attached to P_1. The string slides through the rings P_2 and R without friction. The



ring R, under the action of the forces which act upon it (i. e., the tension of the string and the reaction of the wire) will be in equilibrium at certain points P of the wire. If now the rings P_1 and P_2 be replaced by a point source of light and the eye of an observer respectively, the observer will see images of the light (i. e., actual brilliant points[20]) at certain points Q of the wire. The first theorem of this paper is that the points P and Q are identical.

Let us now think of a weightless and perfectly flexible string with both of its ends attached to fixed points P_1 and P_2. On the string a small heavy ring R is capable of motion without friction. Consider this apparatus as being situated in any field of force for which a force function exists. The ring R under the action of the forces which act upon it (i. e., the weight of the ring in this field of force and the tension of the strings) will be in equilibrium at certain points P of the field. If now the points P_1 and P_2 be replaced by a point source of light and the eye of an observer respectively, the observer will see at P an image of the light (i. e., an actual brilliant point[20]) in the equipotential surface which passes through P. If no force function exists, the point P will be a virtual extra brilliant point[20] of the line of force which passes through P. If, in particular,

[20] For the definitions of the different kinds of brilliant points see Transactions of the American Mathematical Society, Vol. IX, No. 2, pp. 245-279.

the points P_1 and P_2 coincide, the apparatus becomes a plumb line. Then the point P is the image which the observer sees of his eye in the quipotential surface which pass through P.

An apparatus was shown which illustrates the first theorem, and an apparatus was described which illustrates the second theorem. In the second apparatus the equipotential surface is actually assumed by the surface of water which reflects light.

Incidentally, it was shown that in the conical pendulum the angle of deviation from the vertical δ, is such a function of the angular velocity ω which produces the deviation, that ω does not approach zero with δ.

February 1, 1909.

President Trelease in the chair; attendance 75.

The program of the evening had been especially arranged in celebration of the centenary of the birth (February 2, 1809) of Dr. George Engelmann, one of the founders of the Academy, and its first president. Standing not only among the leading medical practitioners of the last generation, Dr. Engelmann was also one of the foremost botanists of his day; for, during the many years of an active, useful life, most of which was spent in Saint Louis, he found sufficient time, in the leisure hours of his practice, to devote to a series of most valuable scientific investigations. And, moreover, in addition to his professional and botanical labors, he was a zealous meteorological observer, keeping observations pertaining to atmospheric phenomena for over forty years.

Dr. Baumgarten opened the program with a very interesting paper entitled "The Personality of Engelmann." Dr. Baumgarten, having been a personal friend of the physician and botanist, was peculiarly well fitted to handle this subject, which he treated in a reminiscent way, making characterizations of a personal rather than more biographical nature. This tribute of Dr. Baumgarten to the memory of his friend was one that bespoke only the most sincere friendship for Dr. Engelmann, and the highest appreciation of his character and achievements.

Professor H. A. Wheeler presented a paper on "Engelmann's Contributions to Geognosy." For Engelmann's reputation extended beyond the borders of his master work in botany and his devotion to local meterology; although his influence in geognosy is perhaps due

less to actual work done in that field than to the stimulation he inspired in specialists of that department. In 1859, he published a paper that concerned itself with the elevation of Saint Louis above sea level, which, aside from its general interest and scientific value, was especially important in that Saint Louis was then the point upon which were based the computations for determining the altitudes of such places in the far west as were visited by the early exploring expeditions of Nicollet, Fremont, Owen and Emery. Engelmann, after a series of barometric observations in 1853, determined a directrix of 404.9 feet for the city of Saint Louis—a figure which differed by only 7.8 feet from the later 412.7 feet mark as determined by precise leveling of government departments, and by only 2.2 feet from the original 410.5 of Nicollet, which was made in 1841 by barometric determinations based upon data furnished by Engelmann himself. While the contributions of Engelmann seem slight when compared with masterly authorities in botany and meteorology, they are, nevertheless, a valuable index of the breadth of the man, of the keen interest he took in the natural sciences, and of his mental caliber and scientific training.

Professor Nipher, in a paper, "Engelmann's Work in Meteorology," told how Engelmann began his meteorological observations when he first settled in Saint Louis, and how he continued them for nearly fifty years. Dr. Nipher explained how this long series of observations enables us to determine the normal rainfall and temperature for Saint Louis, and how they, in turn, are useful in fixing extremes of temperature and rainfall. In 1861 Engelmann published the results of his rainfall observations, which show that June is by far the month of greatest precipitation; and he pointed out that the June rise in the Mississippi is not due to the melting of snows in the mountains, but to heavy and widespread spring rains. The fact that Engelmann gave attention to the rate of rainfall is noteworthy because that is a quantity which must be considered in the design of bridges and other structures that are to carry flood water. After remarking that Engelmann made an early study of the

differences of temperatures and humidity in the city and in Shaw's Garden (which was, he said, on an open prairie three miles from the city) Dr. Nipher concluded with the statements that Engelmann was continuously in co-operation with the weather service in charge of the Smithsonian Institution, and that in many ways his aid was solicited by government officials in charge of work in the far west.

Professor Trelease, of the Missouri Botanical Garden, which possesses Engelmann's invaluable collections, concluded the program with a paper on "Engelmann as a Biologist." He showed a number of drawings which exhibited Engelmann's skill in picturing details of plant structure, among them those made for his thesis, which was published in 1828, as well as the large quarto volume in which his botanical publications were reprinted at the expense of Henry Shaw in 1887, under the editorial direction of the great botanist, Asa Gray of Harvard University. To these were joined specimens of the beautiful prairie flower named Engelmann in his honor, and of the blue spruce of Colorado, which also bears his name. Tersely epitomizing Engelmann's work, and analyzing the economy of time and directness of purpose which enabled him to accomplish in the leisure hours of a busy physician's life more than the average achievement of a botanist whose whole effort is directed to his specialty, Professor Trelease closed by quoting from Engelmann's gifted biographer, Professor Sargent of Harvard University, the prediction that the western plains will still be bright with the yellow rays of Engelmannia, and that the splendid spruce will still cover with noble forests the highest slopes of the Rocky Mountains, recalling to men, as long as the study of botany will occupy their thought, the memory of a pure, upright, laborious and stimulating life.

At the conclusion of the memorial session, the members and guests of the Academy were invited to pass into another room, where were displayed a number of interesting objects connected with or commemorative of Engelmann's life and work. Under the guidance of Mr. H. C. Irish and Mr. Charles H. Thompson, who explained

the several objects, an interesting half hour was spent in the inspection of this exhibit, which included the manuscript and original sketches for Engelmann's thesis as well as the publication itself in a copy with partly colored plates; several volumes of his many thousands of unpublished notes and sketches; the simple dissecting microscope and the elaborate compound microscope made by Hachet; the Jubilee Medal struck by the Academy in 1906, bearing Engelmann's portrait; an illustration of the Colorado Engelmannia spruce; and specimens and original descriptions of the three genera of plants that have been dedicated to his memory in the name of *Engelmannia.*

The following were elected to membership: J. W. Blankinship, Ben Blewett, C. H. Danforth, Victor E. Emmel, Henry V. Farr, Robert H. Fuhrmann, W. W. Ohlweiler, George M. Reed, Robert S. Schlueter, Charles H. Thompson, Meyer Wiener.

FEBRUARY 15, 1909.

President Trelease in the chair; attendance 75.

The following program had been arranged, to commemorate the centenary of the birth of Charles Darwin (February 12, 1809.):

Darwin as a Naturalist.....Professor S. M. Coulter
Darwin's Influence Upon Geology.....
.....Professor W. E. McCourt
The Natural Selection Theory and Its Latter Day Critics .....Professor J. F. Abbott
Some Aspects of Darwin's Influence Upon Modern Thought.....Professor A. O. Lovejoy

At the conclusion of the special meeting, Professor Nipher presented to the Academy some changes in the manner of his experiments, and some of the additional results that he has obtained in his studies of momentum effects in electric discharges.

The following were elected to membership: George L. Allen, F. W. Brockman, Murray Carleton, Peyton T. Carr, Daniel Catlin, Harley P. Chandler, Enos Clarke,

Malvern B. Clopton, Henry C. Garneau, William L. R. Gifford, John H. Gundlach, Henry P. Hilliard, Robert McKittrick Jones, Alfred L. Kammerer, Alfred Q. Kennett, Robert McCulloch, Thomas H. McKittrick, Alfred Lee Shapleigh, Wilson P. H. Turner, Daniel S. Tuttle, C. A. Waldo, Percy Werner, Oscar L. Whitelaw, H. E. Wiedemann.

March 1, 1909.

President Trelease in the chair; attendance 54.

Mr. Julius Hurter read a paper entitled "The Amphibians and Reptiles of Arkansas," compiled by himself and Mr. John K. Strecker, Jr.[21]

Mr. Hurter also showed specimens of the blind salamanders of the world—*Proteus anguinus* (European blind salamander), *Typhlotriton spelaeus* (Missouri), and *Typhlomolge rathbuni* (Texas).

The following resolution was adopted:

The Academy of Science of St. Louis, an organization equally interested in the preservation and the proper and consistent utilization of the gifts of Nature, respectfully urges on the Congress of the United States the desirability of promptly passing the House Joint Resolution now under consideration, as a means of continuing the provisions of the Burton Bill, limiting the diversion of water from Niagara Falls, until equally effective but more permanent protection of the Falls shall be secured by adequate legislative or executive action.

On proper motion, duly seconded and unanimously carried, at a meeting of the Academy held on the first day of March, 1909, the foregoing memorial was adopted as expressing the views of the Academy; and copies were ordered sent to the Speaker of the House of Representatives, the President of the Senate, and the gentlemen who represent Missouri in both branches of the present Congress.

The following were elected to membership: George D. Barnard, George Warren Brown, Theophilus Conzelman, Harvey L. Christie, Hanford Crawford, Dwight F. Davis, Charles H. Duncker, Jacob Furth, C. Stuart Gager, Benjamin Gratz, C. H. Huttig, David F. Kaime, H. P. Knapp, John Lawrence Mauran, Fritz Nisbet, Leo Rassieur, Charles A. Stix, W. S. Stuyvesant, M. E. Towner, Julius S. Walsh, Rolla Wells, Louis Werner.

[21] Published in Transactions, Vol. XVIII., No. 2.

March 15, 1909.

President Trelease in the chair; attendance 100.

A paper on the "Birds of the Missouri Botanical Garden," by Mr. Otto Widmann, was read.

The following resolution was passed:

On the recommendation of its Entomological Section, and with the approval of the Council, the Academy of Science of St. Louis, on duly seconded and passed motion at its regular meeting of the fifteenth of March, 1909, respectfully urges on the members of the General Assembly of the State of Missouri, the importance of passing House Bill No. 575, and Senate Bill No. 197, providing for adequate inspection of nursery stock.

At the present moment the entire orchard and nursery industry of the State is imperiled by a threatened introduction of the dreaded brown-tail moth, in the bare restriction of which New England has for years waged a costly warfare. Nothing but adequately planned and efficiently administered state inspection can protect this important industry of Missouri in the present or future crises; and no other action can prevent neighboring states from defending themselves by restricting importations of Missouri nursery and orchard stock.

The following were elected to membership: Ernest Robert Buckley, H. A. Buehler, R. S. Colnon, Frank P. Crunden, E. G. Eberle, James H. Ferris, J. D. Filley, Cecil D. Gregg, William E. Guy, Arthur O. Lovejoy, Richard McCulloch, Albert T. Perkins.

April 5, 1909.

Professor Nipher in the chair; attendance 65.

Professor Winthrop Holt Chenery presented a paper, illustrated with lantern slides, on "The Relation of the Physiography of the Iberian Peninsula to the Development of the Spanish People."

The paper attempted to survey the more important physical aspects of the Spanish-Portuguese peninsula, as they have affected the development of the people from the dawn of history until the end of the Middle Ages. In the absence of previous studies of this type upon Spain, the materials had been gathered from various sources, too numerous to be cited in an abstract.

Orography, geology and climate were treated at some length. The continental, mountain-girt topography of the peninsula, with its consequent diversity of climates, was emphasized, as also the controlling

influence of the semi-arid table-land with its fluctuating rivers in deep young valleys.

The unsuitability for agriculture of much of the plateau, it was shown, has favored the continuance of sheep grazing over wide areas, causing a remarkable survival in a West European state of a relatively large nomadic population living under almost primitive conditions.

The relation of the peninsular geology to the important development of mining industries by the ancients was discussed. It was shown, however, that Spain by its peculiar geographical conformation was not in a favorable position to develop industry and commerce in the Mediterranean, and, in consequence, she was forced, in spite of a rather arid climate, to become chiefly an agricultural country. From this there resulted in ancient times a notable growth of population and civilization in those parts of the peninsula (viz., the coast regions and the alluvial plains of the Betis, Ebro and Lower Tagus) where irrigation was practicable.

This natural gravitation of the population toward the regions made fertile by irrigation was in the Middle Ages disturbed by adverse political conditions which caused a movement away from the unprotected, pirate-infested coasts into the neighborhood of the strongly fortified mountain towns of the plateau. Since the re-establishment of peaceful conditions, however, there has been a steady movement of population back to those regions which were in ancient times centers of civilization, until Madrid (artificially maintained as the political capital) is left the only important town on the plateau.

The ethnology of the peninsula was briefly discussed, showing how the mountainous nature of the country has developed and preserved special types.

The following letter from President Trelease was read, and checks amounting to $2,500 presented to the Academy:

St. Louis, Mo., April 5, 1909.

To the Council, Academy of Science:

I have pleasure in handing to the Council, herewith, the sum of $2,500.00, which has been contributed by members (and a few friends who are not members) of the Academy to replace a like sum that has been withdrawn from the invested funds to meet current expenses within the last few years. An alphabetical list of contributors is appended. It has been thought best not to indicate the sum contributed by each donor; but such a list has been audited, in comparison with the fund itself, by Professors Nipher and Langsdorf, at my request, so that it might be known that all contributions and contributors are accounted for. The thanks of the Academy no doubt will be expressed to the donors in a suitable resolution.

I recommend that the Council add to this gift the sum of $1,000.00 from the Academy treasury (of which $792.63 represents the balance

from last year), thus bringing the fund up to $3,500.00; and that this, which is equal to the total expenditure from the original endowment, be deposited, while awaiting more productive investment, in either the St. Louis Union or the Mississippi Valley Trust Company, apart from the current treasury account of the Academy.

I also suggest that in future such a separate deposit be made of endowment funds, whenever investments mature and money awaits reinvestment; and that the Council recommend to the Academy the adoption of a rule providing that hereafter no part of the endowment fund shall be considered applicable to current expenses unless duly authorized in each instance by a vote of the Academy, on a recommendation of the Council which shall have been included in the notice of the Academy meeting at which it is to be voted on.

Very respectfully,

(Signed) WILLIAM TRELEASE,
President.

ALPHABETICAL LIST OF DONORS.

J. F. Abbott, Adolf Alt, L. W. Andrews, O. F. Ball, W. K. Bixby, W. A. Brandenburger, M. S. Brennan, W. G. Brenneke, D. S. Brown, W. H. Bryan, B. F. Bush, G. O. Carpenter, R. S. Colnon, S. M. Coulter, G. Cramer, A. W. Douglas, G. F. & A. F. Durant, Charles Espenschied, A. E. Ewing, E. R. Fish, D. R. Francis, F. W. Frerichs, F. R. Fry, R. M. Funkhouser, G. A. Geitz, N. M. Glatfelter, M. A. Goldstein, H. C. Haarstick, George Homan, H. Aug. Hunicke, Julius Hurter, W. C. G. Kirchner, Mary J. Klem, George Lang, Jr., A. S. Langsdorf, J. J. Lichter, Alice Litton, Edw. Mallinckrodt, W. C. Mardorf, Geo. D. Markham, Richard McCulloch, Robert Moore, H. G. Mudd, Aug. Nasse, Naturalists' Club, F. E. Nipher, G. Pantaleoni, C. P. Pettus, Julius Pitzman, Amand Ravold, C. M. Rice, W. H. Roever, Enno Sander, W. E. Sauer, H. von Schrenk, John Schroers, Frank Schwarz, Henry Schwarz, Greenfield Sluder, D. S. H. Smith, Joseph Spiegelhalter, Hugo Summa, Wm. Taussig, R. J. Terry, Arthur Thacher, H. H. Tittmann, Wm. Trelease, H. A. Wheeler, H. M. Whelpley, Edwards Whitaker, John Zahorsky.

A motion was passed that the chair appoint a committee of three to draw up suitable resolutions, embodying the sense of the letter from the President.

The following were elected to membership: Paul R. Baer, Joseph R. Barroll, George W. Bock, Carl Fisch, M. E. Hard, J. A. Holmes, Walter F. Hendrick, Jacob Klein, Frank Mesker, John W. Noble, Tom Randolph, Maurice Ricker, Franklin L. Ridgely, Philip C. Scanlan, Charles Parsons Senter, Henry Studniczka.

The death of Mr. James B. Gazzam was announced.

April 19, 1909.

President Trelease in the chair; attendance 25.

The death on April 5th of Dr. H. August Hunicke, Corresponding Secretary of the Academy since 1904, was announced, and the President appointed Messrs. Andrews, Wheeler and Stevens as a committee to draft a suitable memorial.

Dr. Robert J. Terry read a paper on "Observations on the Development of the Vomer."

The observations made on the development of the vomer in *Caluromys philaucler* affects the question of the homology of the mammalian vomer. Is the single vomer of mammals comparable with the single parasphenoid or the paired vomers of lower forms? Except in man the vomer of mammals has been found to arise from a single center. Lately, however, the bone in question has been seen in a marsupial taking origin from two centers apparently, and to be accompanied by a parasphenoid ossification. It seems also to be the case in *Caluromys* that the origin of the base is paired.

Dr. Joseph Grindon then spoke on "The Protection against Disease Afforded by Certain Substances in the Blood."

The following were elected to membership: F. C. Ameiss, Samuel McCutcheon Bain, J. Christian Bay, F. H. Britton, George W. Cale, Jr., A. R. Crook, John H. Duncan, M. E. Duncan, H. S. Fawcett, Charles W. Fullgraf, Harrison Garman, C. P. Gillette, Oscar Herf, Philip Hoffmann, Charles R. Keyes, Max Kotany, Rufus U. Leonori, E. G. Lewis, N. W. McLeod, George T. Moore, Frederick S. Plant, Maxime Reber, Samuel Sale, John B. Shapleigh, Paul C. Standley, H. N. Spencer, C. P. Walbridge, Henry L. Wolfner.

May 3, 1909.

President Trelease in the chair; attendance 45.

Professor F. E. Nipher presented a paper on "Lessons to Be Learned From Common Things."

Professor William Trelease presented, with numerous lantern illustrations, an oral abstract of a paper on the Mexican fiber Agaves known as Zapupe.[22]

The following resolution, recommended by the Council, was adopted:

Realizing that the whole country is taking stock of the natural resources which remain, and believing that the conservation in particular of the forest and water resources of the State of Missouri are of particular interest to the people of this State; realizing, furthermore, that available statistics show that there has been a decrease of 29% in the amount of lumber produced in the State during the last ten years; realizing, furthermore, the importance of conserving the forest and water resources of the State not only from the standpoint of the timber to be actually used for building and other purposes, but also with the view that the conservation of the forests within the boundaries of the State is desirable in order that the water supplies may be conserved, the farming lands preserved in their integrity and opportunities preserved for recreation grounds for the people; realizing, also, that some twenty-four States have already taken advanced steps looking toward the conservation of their forest and water resources, be it

Resolved, That the Academy of Science of St. Louis endorses the report made by the forest and water commissions to the Governor, and endorses the bills now pending before the Legislature of Missouri, looking toward the appointment of permanent Forest and Water Commissions, and that copies of this resolution be sent to the Governor and presiding officers of the Senate and House of Representatives.

The following report of the Entomological Section was submitted:

St. Louis, Mo., May 3, 1909.

To the Academy of Science of St. Louis:

In reporting the progress of the Entomological Section I wish first to ask your pardon for the long interval which I have allowed to pass since my last report in January of this year. Lack of time and absence from the city for some time are the causes.

The section has held its meetings regularly on the last Thursday evening of each month, except in January, when there was lack of a quorum, owing to the inclement weather.

The average attendance was eight members and five visitors. At the March meeting Mr. Ernest Schwarz presented a case containing bark of white oak upon which was placed a number of underwing moths (Catocalae) showing the remarkable color protection of these

[22] Published in the Transactions, Vol. XVIII, No. 3.

insects. This case is now in the museum collection. At this same meeting Mr. Hermann Schwarz spoke on "Collecting in Mexico," illustrated with many stereopticon views as well as insects he had collected there. At the April meeting Mr. Philip Rau exhibited a number of golden rod galls together with one species of diptera, and five species of hymenoptera, which had emerged from them. Prof. J. F. Abbott, chairman of the section, lectured on "Collecting in Japan," illustrated with stereopticon views and a variety of coleoptera collected by himself.

It has been decided to continue the meetings throughout the summer with an occasional field meet. The section is now composed of nine members.

It is believed that a lot of pent-up energy among the membership might be set free by the acquisition by the Academy of cases for insects. The Section is perfectly willing to do its share in getting up a good collection for the museum if the Academy will furnish the cases.

Respectfully submitted,

(Signed) HERMANN SCHWARZ,

Secretary of the Section.

The following were elected to membership: Ernst A. Bessey, Winthrop Holt Chenery, S. W. Fordyce, F. M. Rolfs.

MAY 17, 1909.

Vice-President Andrews in the chair; attendance 65.

The following resolutions were adopted:

In Memory of Henry August Hunicke.

Dr. Henry August Hunicke, at the time of his death on the fifth of April, nineteen hundred and nine, had been a member of the Academy of Science of St. Louis for rather more than twelve years, during five of which he held the office of corresponding secretary.

His active interest in everything appertaining to the labors of the Academy is indicated, not only by his contributions to its scientific proceedings, but also, to an even greater degree, by his active participation in the business of the Council, in matters of organization, in the discussion of questions of policy and in the promotion of measures designed to broaden the scope or to increase the usefulness of the Academy.

He was an effective speaker, because his outlook and his sympathies were both broad and deep. Although a keen debater, he was uniformly considerate of the feelings of others and never permitted himself to treat his opponent of the moment with anything less than the most perfect courtesy. His spirit was ever helpful, encouraging, warmly appreciative of merit or even of good intent, but he was nevertheless quick to detect and to comment upon faults in logic or on errors of any sort. Such criticisms were always without rancor and were delivered with a touch of humor and with so delicate a tact, that, while they enlivened debate, they rarely or never gave offense.

As a councilor, his advice was highly valued, because he looked to the end, being not easily diverted from the main objective or disposed to waste time over side-issues or trifles, and because he neither underestimated the adverse view nor overstated his own.

In the various capacities, as Adjunct Professor at Washington University, as a resourceful and able technologist, and as a close student of certain strictly scientific applications of the theory of thermodynamics, Dr. Hunicke enjoyed in full measure the respect of those who were in a position to judge his work, and so achieved his

reputation; but in the minds of his colleagues of the University and of the Academy, his truest claim to distinction lies in the exceptional qualities of heart and character, which endeared him to his friends, which were a constant inspiration to all who came within the sphere of his influence and of which the memory constitutes a living monument in his honor.

The Academy of Science of St. Louis places this record in its archives as a brief token of respect and as an expression of its sense of the severe loss which the Academy and the world has sustained in his death.

(Signed) LAUNCELOT W. ANDREWS,
CHAS. D. STEVENS,
H. A. WHEELER,
Committee.

Professor W. E. McCourt gave an illustrated lecture on "Diamonds in Arkansas."

Professor McCourt first gave a general account of the properties of the diamond, and an account of some of the famous diamonds of history. Then the general commercial occurrences of the diamond were considered—namely, India, Brazil and Africa, whence the world's supply of diamonds has largely come. Diamonds have also occurred in the United States, but nowhere in very large quantities.

In 1906, however, diamonds were found derived from a parent rock in Pike County, Arkansas, near the town of Murfreesboro. The presence of the rock in this region, similar to rock in which diamonds were found in Africa, has been known for some time, and the State Survey has mapped one of the areas. The igneous rock is a peridotite which has been pushed up through the Carboniferous and Cretaceous quartzites and sandstones, and in places is covered by beds of Post-Tertiary and Quaternary formations. But there does not seem to have been any metamorphism accompanying the intrusion of this material. This peridotite is a dark colored, basic, igneous rock which contains olivine, augite, magnetite, mica and perofskite. In some places the rock is exceedingly hard and dense, but in others it has weathered to a yellowish and greenish soft material, to a depth of from twenty to fifty feet. Covering the region to a depth of a foot or so is a black gumbo soil which contains fragments of the hard peridotites and the country rock.

The work in this region has not been very extensive, but bore holes have been made in several places, one reaching to a depth of 205 feet in the hard rock; several companies have located on the area; and stones to the number of 600 have already been found. The largest stone is six and a half carats. Some have been cut and are

valued at $104.00 a carat. The colors vary—most of them being white, brown and yellow, though one blue diamond has been found and several black ones.

From these indications this area seems to contain a mass of rock similar to the rock in South Africa. But as to the number of diamonds which may be found deeper in the peridotite, that, said Professor McCourt, is a question which can only be settled by actual mining and testing. The results which have been shown by the more or less spasmodic exploitation, however, seem to indicate a good promise.

Professor Nipher reported progress in his experiments on "Momentum Effects in Electric Discharge."

Dr. Jesse S. Meyer was elected to membership.

JUNE 7, 1909.

President Trelease in the chair; attendance 25.

Professor W. E. McCourt exhibited a number of photographs taken in the Onondago Cave, near Leasburg, Mo., and described the formations found there.

Professor F. E. Nipher gave a verbal account of some of his recent work on electric discharge, stating that his paper on the subject has not yet been completed.

The death of Dr. Joseph Spiegelhalter, a former Vice-President of the Academy, was announced, and the President appointed Prof. F. E. Nipher, Dr. Gustav Baumgarten, and Dr. Adolf Alt a committee to draft a memorial.

The following were elected to membership: Charles Edwin Bessey, Lyster H. Dewey, Reginald R. Gates, Francis Ernest Lloyd, D. T. MacDougal, Andrew Meyer, Jr., C. J. Pennock, B. Shimek, John K. Strecker, Jr., Herman Tuholske.

OCTOBER 18, 1909.

President Trelease in the chair; attendance 90.

Professor R. J. Wallace, late of the Yerkes Observatory, presented for discussion "The Physical Possibilities and Limitations of 'Autocrom' Color Photography."

The following resolutions were presented:

In the death of Dr. Joseph Spiegelhalter on June 7, 1909, the Academy of Science of St. Louis has lost one of its oldest and most valued members.

While not especially active in the scientific work of the Academy as such, he has served it for a number of years in its Council and as Vice-President.

His practical scientific mind has had an ample occasion to exert itself to the utmost as Health Officer of the city when it was stricken by the epidemics of cholera and yellow fever. The practical organization of the Health Board was his work.

A cultured man, of ardent patriotism, of energetic, active mind, he was withal a genial open-hearted and open-handed man, ever ready to embrace and help along the high aims of science in her different aspects.

In him the Academy of Science of St. Louis mourns a congenial member and a trusted officer.

(Signed) FRANCIS E. NIPHER,
ADOLF ALT,
G. BAUMGARTEN.
Committee.

NOVEMBER 1, 1909.

President Trelease in the chair; attendance 40.

Professor A. S. Langsdorf presented a paper on "Lightning and Lightning Protection."

The following were elected to membership: Walter Baumgarten, V. P. Blair, H. Harold Hume.

NOVEMBER 15, 1909.

Vice-President Andrews in the chair; attendance 38.

Mr. J. J. Kessler presented a paper, illustrated with lantern slides, on "Metals and Alloys under the Microscope."

Mr. James Arbuckle was elected to membership.

DECEMBER 6, 1909.

President Trelease in the chair; attendance 38.

Dr. R. R. Gates delivered an instructive lecture on "The Cytological Aspect of Evolution by Mutation."

The following were elected to serve as a Nominating Committee for the annual election of officers: Messrs. George W. Bock, Frank Schwarz and J. F. Abbott.

The death of Dr. T. Griswold Comstock was announced.

Mr. John J. Cole was elected to membership.

DECEMBER 20, 1909.

President Trelease in the chair; attendance 27.

Dr. V. E. Emmel presented a paper entitled "Observations on the Differentiation of Regenerating Epidermal and Striated Muscle Tissue."

Professor F. E. Nipher presented the continuation of his work on electric discharge.

The Nominating Committee, appointed at the previous meeting to nominate officers for the year 1910, made the following report:

Dec. 20, 1909.

The Nominating Committee elected at the meeting of the Academy of Dec. 5th has decided upon the following names for officers for the ensuing year, which names it desires to put in nomination before the Academy:

For President	William Trelease
For First Vice-President	D. S. H. Smith
For Second Vice-President	Francis E. Nipher
For Recording Secretary	Walter E. McCourt
For Corresponding Secretary	George T. Moore
For Treasurer	H. E. Wiedemann
For Librarian	Wm. L. R. Gifford
For Curators	Julius Hurter
	Joseph Grindon
	Philip Rau
For Directors	Otto Widmann
	Adolf Alt

In proposing the name of Mr. Gifford for Librarian, the Nominating Committee had in mind the fact that the duties of this office would be of a radically different nature from what they have been in the past and wishes to take this opportunity of testifying to the carefulness, energy and unusual ability displayed by the present incumment, Miss Mary J. Klem, in the past, in which sentiment it feels assured that the Academy will concur.

Respectfully submitted,

(Signed) GEO. W. BOCK,
F. SCHWARZ,
J. F. ABBOTT.

The following were elected to membership: Arthur E. Bostwick, Lewis M. Dougan, Heber Robarts.

REPORTS OF OFFICERS.

President's Address.

Fellow Members:

The close of a year, in scientific as in business affairs, offers a convenient opportunity for retrospection and presents an obligation to look and plan forward.

In the year just closed the Academy has been true to the broad purposes for which it came into being, and your officers have done what lay in their power to ease its passage consistently along these lines.

The sixteen meetings provided for by the By-Laws and the long-standing practice of the Council have been held. At them have been discussed topics of general as well as technical interest in selected fields of scientific activity, presented in a manner at once attractive, instructive and stimulating. Though a regrettably small fraction of the total membership of the Academy is ever represented at any one meeting, the attendance (averaging 53) has compared favorably with that of preceding years and has shown a gratifying interest in the program offered.

The Curators have devoted much time and pains to the little museum collection, in an effort to render it both interesting and educational, and after several of the meetings the audience has adjourned in a body to the museum.

The Librarian reports the customary increase in the library, chiefly through the Academy's extensive exchange relations with the learned bodies of the world. Early in the year, as the result of consideration by the Council, a committee was appointed to consider ways and means by which the library may be made more useful to our members and to the community as a whole, and the suggestions of this committee have been made the basis of administration. As in the preceding year the Academy has co-operated with other organizations toward the preparation and issuance of a placing catalogue for the scientific publications that are represented in the libraries of Saint Louis, which it is hoped may be printed and thus made available in the near future. No single step seems so likely to promote the ready use of scattered literature and incidentally to cause increased reference to the Academy's library as this; and the policy of administration adopted by the special library committee of last year, and likely to be followed by the Council, is such as to give every possible facility for such reference.

In the year just closed, four scientific papers have been published as numbers of the Academy's Transactions; and with a concluding brochure, largely devoted to a record of proceedings for the years 1908 and 1909, now in preparation by the Secretary, the eighteenth volume of Transactions will be completed.

The material interests of the Academy have been exceptionally promoted through the activity of its members in the past year.

The active membership, which stands for and furnishes means for carrying out the purposes for which the Academy exists, has experienced a net increase of 109 (or 40 per cent.), placing it today

at a higher point (380) than ever before (293, seven years ago), although death has claimed more than the usual number of devoted and energetic members—T. Griswold Comstock, James B. Gazzam, Henry August Hunicke and Joseph Spiegelhalter.

By generous contributions from a large number of members, the Council have been enabled to add $2,500.00 to the treasury balance brought forward from last year and by withdrawal from the current revenue they have increased this to a total of $3,500.00, which has been added to the endowment of the Academy—thus replacing in full a gradual shrinkage of this reserve incident to the increased expenses necessitated by maintaining our present home. A separate account has been opened for the endowment and a vote recorded that the income from it, only, is applicable to current expenses; and the Treasurer tonight reports a balance of $231.15 in the general treasury after the expenses of the year have been met, in addition to the endowment which through further gifts from members, apart from the earned interest, now stands at $7,400.00. This should encourage us to further effort in the same direction.

Though it is very gratifying to your officers to be able to present this evidence of a sane financial administration of the business affairs intrusted to them, I should not wish to give the impression that their task has been an easy one, or to be understood to indicate that attention to book-keeping is the only obligation to be met by their successors in office. On the contrary, an active membership watchfully sustained at not less than its present number, and the derivation of all possible revenue from sharing our meeting-place with others, are needed to enable your Council, year after year, to report that we have lived within our means even by the practice of the most rigid economy. The decent habitability of our building calls for a considerable immediate and a regular annual expenditure for renovations—that have been left, thus far, for a more favorable time, only imperatively necessary structural repairs having been made since we have occupied the building. The most direct way of meeting these and similar pressing current needs lies in a further increase of membership. When even they have been surely provided for, provision will have been made for maintenance only, and that on a basis not commensurate with the purposes of the Academy.

From its foundation, the organization has enjoyed an honorable and enviable reputation as a center of scientific publication. When it had few members and met as a tenant-at-will, this reputation was made and sustained through oft-repeated contributions of money; and the addresses of its early Presidents abound in appeals for means wherewith to nourish this, its soul. More numerously constituted, and in its own home, its need in this direction is as great as in its darkest days. Your retiring officers are able to report that while the responsibility has been theirs, no worthy paper offered has been refused publication; but partly because of the absence of visible funds for publication, the papers so offered this year have been neither long nor numerous. It would be wrong to assume that those who now go into office can this year issue all of the papers that may be

and ought to be presented for publication, though the Council have already bravely undertaken to bring out two brochures of the nineteenth volume. If they are to publish what ought to be published, increased revenue must be provided or special gifts of money must be solicited.

Your officers are charged only with administering the business of the Academy and holding it to its declared purposes. They must of necessity see and either meet or avoid financial difficulties. I submit for your thoughtful consideration the question whether, if not actively supported by you individually in every effort to meet such needs, they are not likely in the long run to have confined their administrative effort to escaping them; whether in seeing and reporting them, they may not justly claim to have done their full share of the duty—which is as personal to each one of us who cherishes the Academy as to the few to whose direct supervision we entrust its affairs.

You can make the task of administration plain and simple if you will furnish the means of adequate administration. You will furnish the means immediately needed if you will promptly add 150 to the roll of active members. This is your duty, rather than that of your officers; it is not difficult; will you not do it? Membership in the Academy is worth while. Every scientific worker in the community owes it to himself as an investigator and to his science. No man trained in science but compelled to devote his life effort to its application in the arts and professions can afford to dissociate himself from the closest possible contact with investigators and their investigations. Bare examination of the subjects that have been popularly presented before the Academy during the last decade is enough to carry conviction of the educational value of membership to professional man, teacher and business man alike, for touch with the scientific progress of the world is essential to all; and there are few more desirable and no more worthy objects to which money may be given than those which the Academy prosecutes by aid of the six dollars contributed by each local member in the payment of his annual dues. Last year 135 members were elected. Their proposal blanks bear the names of only 33 members as sponsors—not even half of whom may be assumed to have presented to these candidates the advantages of membership. This privilege is neither personally nor exclusively theirs, and I suggest that each of us make haste to claim his own share in it.

I have confined myself closely to the present activities and urgently vital needs of the Academy; not because these represent what I see as most desirable or necessary in its life, but because they must be reckoned with at once, while other and greater needs and activities can not be seriously considered until these have received adequate attention. Earnest, individual, helpful interest in meeting the minor crises of today will ensure a future fruition of which, as of that of the past half century, the community, the Academy as an organization, and each of its members who has aided in its work according to his ability and talent, may be justly and affectionately proud.

(Signed) WILLIAM TRELEASE,
President.

Treasurer's Report.

RECEIPTS

Balance for 1908	$ 792.63
Interest on balance in Franklin Bank	17.15
Interest on real estate loan of $3,000	165.00
Rent from tenant societies in building	720.00
Dues from members	2,004.15
Endowment fund (contributed)	3,460.83
	$7,159.76

EXPENDITURES.

Salaries (thirteen months)	$1,300.00
Printing	493.63
Taxes (water license and sprinkling)	36.09
Insurance	112.00
Telephone	58.00
Postage	32.72
Fuel	213.82
Light	58.21
Repairs	39.75
Secretary's records	11.20
Current expenses	97.86
Sundries	14.50
	$2,467.78
Gross receipts	$7,159.76
Gross expenditures	2,467.78
Cash on hand, December 31, 1909	$4,691.98

One thousand dollars were transferred from the cash balance to the endowment to replace that amount used in several previous years for current expenses, making the endowment fund in cash in the St. Louis Union Trust Co., $4,460.83. In addition to this the Academy holds, as additional endowment, a mortgage of $3,000.00. The cash balance now in the hands of the Treasurer amounts to $231.15.

Respectfully submitted,

(Signed) Chas. D. Stevens,
Treasurer.

Librarian's Report.

The Librarian reported that the accessions to the library for the year 1909 by exchange with 99 home and 219 foreign societies amounted to 501 volumes and 591 pamphlets, and by donations 99 volumes and 113 pamphlets.

The Transactions for the year were sent to 164 home and 422 foreign societies.

During the year the following donations to the library were received:

Dr. L. W. Andrews—Two pamphlets on chemistry.
Dr. G. Baumgarten—Four books on botany.
Dr. C. H. Danforth—One botanical and one zoological pamphlet.
Mr. J. A. Drushel—One geological pamphlet.
Dr. Edward Evers—Copies of Globus and Naturwissenschaftliche Rundschau.
Mr. D. K. Greger—One pamphlet on geology.
Dr. J. Orth—Four medical pamphlets.
Mr. H. D. Reed—Three zoological pamphlets.
Dr. Heber Robarts—A book and a pamphlet on radium.
Mr. W. H. Roever—Two mathematical pamphlets.
Saint Louis Chemical Society—A biographical sketch of Dr. H. A. Hunicke.
Dr. Enno Sander—Copies of Science and Pharmaceutical Journals.
Dr. T. J. J. See—One astronomical pamphlet.
Dr. Wm. Trelease—One pamphlet on Darwin.
Mr. Frank Springer—One geological pamphlet.
Dr. Meyer Wiener—Five medical pamphlets.

Curator's Report.

The Curators reported that during the year donations were received from:

Dr. Gustav Baumgarten—Seal of the Western Academy of Sciences.
Mr. F. C. Greene—Fossil cephalopods from Fox Hill Sandstone, South Dakota.
Dr. A. E. Horwitz—Five sea-urchins from the coast of France.
Mrs. H. A. Hunicke—Portrait of Dr. H. Aug. Hunicke.
Miss Mary J. Klem—Specimen of fossil Sigallaria from Veedersburg, Ind.
Dr. Albert Merrill—Fine specimen of molybedenum of lead from Colorado.
Mr. Ernest Schwarz—Case showing mimicry of the Catocala moth.
Dr. George W. Bock kindly labeled a case of Coleoptera.

Report of the Entomological Section.

St. Louis, Mo., Jan. 3, 1910.

To the Academy of Science of St. Louis:

Since my last report to you in May of the last year, the Entomological Section has met regularly every month except in June and August.

At the May meeting Mr. H. Schwarz presented a paper on Scale Insects (Coccidae) with special reference to Kermis galliformis Riley. Mr. Rau reported having bred some Chalcid parasites from eggs of Stagmomantis carolina Linn. He also stated having preserved an egg

of the potato beetle, Doryphora 10-lineata, which is being pierced by an aphid.

The Section held its field meet at Fenton, Mo., July 17-18, which was attended by five members and two guests.

At the September meeting Mr. Philip Rau read a paper entitled "Duration of Life of Samia cecropia." It was agreed that the paper be presented to the Academy for publication which, we are pleased to note, has since been accepted by the Council and is now in the hands of the printer. At this meeting several members reported having collected and prepared a lot of material for the museum collection to be placed there upon receipt of cases from the Academy.

At the October meeting Prof. J. F. Abbott told of his experiences in Manchuria during the past summer and Mr. Hermann Schwarz reported on a recent collecting trip made through St. Louis and St. Charles Counties, Missouri, illustrating same with a number of stereopticon views made from photographs taken by himself.

At the November meeting Dr. Geo. W. Bock read a paper on "Spiders," supplemented by a number of excellent drawings showing the anatomical structure of these arthropods. Mr. Ernest Schwarz showed catocalae eggs deposited in bark and explained that the eggs of this genus of moths are not always laid on the food plant of the larvae. The subject of relation of insects to their food received considerable attention.

At the December meeting Mr. J. T. Monell read a very instructive paper on the "Homoptera," showing in connection a series of microscopic mounts of aphids. A letter from Dr. Wm. Barnes of Decatur, Ill., was read, in which he invited the entomologists of St. Louis to meet with those of Chicago at Decatur, Jan. 16th, and it was agreed that as many as can, join in making this meeting productive of good results.

The average attendance for the last six meetings was 6 members and 3 visitors.

The Section at present consists of ten members.

Respectfully submitted,

(Signed) HERMANN SCHWARZ,
Secretary of the Section.

Issued, July 5, 1910.

Transactions of the Academy of Science of St. Louis.

VOL. XVIII. No. 1.

AIR-SHIP PROPELLER PROBLEMS.

CALVIN M. WOODWARD.

Issued, March 14, 1908.

PUBLICATIONS.

The following publications of the Academy are offered for sale at the net prices indicated. Applications should be addressed to The Librarian, The Academy of Science of St. Louis, 3817 Olive St., St. Louis, Mo.

TRANSACTIONS (in octavo).

Vol.	Number.	Price per number.	Price per vol.	Price in set.
1	1* 2† 3, 4	..... $4.00 2.00 each.	$7.50 (Nos. 2-4 only.)	$7.00 (Nos. 2-4 only.)
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8‡	1, 3 to 6 8, 10, 12 2, 7, 9, 11	25 cts. each. 50 cts. each.	3.75	3.50
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Continued on page 3 of Cover.

AIR-SHIP PROPELLER PROBLEMS.

CALVIN M. WOODWARD.

1. WHAT IS THE HORSE-POWER REQUIRED TO PRODUCE A GIVEN PULL OR THRUST BY MEANS OF ONE OR MORE AIR-SHIP PROPELLERS, WHEN THE FRAME IS ANCHORED?

The net horse-power of the motor is measured by the kinetic energy imparted to the air acted upon by the propeller. I assume that an absolute velocity of v feet per second is given to a cylindrical stream of air, originally still, and that the cross-section of the stream (or streams if there be more than one propeller) is the same as the area of the propeller circle (or circles). Call this area A sq. ft., and let the given or required pull or thrust be P lbs.

Since the thrust forward, or pull upon the anchorage must equal the backward push upon the air, we have the general equation

$$P = Ap. \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad [1]$$

in which p is the average push or action in lbs. per sq. ft., upon the cylinder of air.

Hence the volume of air acted upon and set in motion every second is Av; its weight is Awv, in which w is the weight in lbs. per cu. ft.; its mass is $\frac{Awv}{g}$, and its kinetic energy is $\frac{Awv^3}{2g}$, being the mass into half the square of its velocity.

Now v is determined by p in accordance with the laws for the flow of gases; but since p is small compared with ordinary atmospheric pressure, all changes in density and temperature may be neglected, and the flow of air may be assumed to follow closely the laws for the flow of liquids.

The pressure of p pounds per square foot in the cross-section of the cylinder of air, produces a flow or current like the flow or current thru an opening between two indefinitely large tanks of air in one of which the atmospheric pressure is 2117 lbs. per sq. ft., and in the other, $2117 + p$ lbs. per sq. ft.

Hence I use the familiar hydraulic formula

$$v^2 = 2gh$$

in which $2g$ is approximately 64 and h is the "dynamic head" of the current whose value is

$$h = \frac{p}{w} = \frac{P}{Aw} \quad \text{.....[II]}$$

$$\text{Hence } v = \sqrt{\frac{2gP}{Aw}} = \frac{16}{r}\sqrt{P} \text{ nearly} \quad \text{.....[III]}$$

if $A = \pi r^2$, and $w = 0.08$.

Substituting for v in the expression for the kinetic energy, we have the Kinetic Energy of the air-current, and hence the work done per second by the motor-driven propeller is

$$K.\,E. = \frac{Aw}{2g}\left(\frac{2gP}{Aw}\right)^{\frac{3}{2}} = \frac{16}{r}P^{\frac{3}{2}} = vP \quad \text{.....[IV]}$$

so that we have for the net horse-power actually exerted, dividing by 550, the horse-power-work in one second,

$$H = \frac{vP}{550} = \frac{8P^{\frac{3}{2}}}{275r} = .0515\frac{P^{\frac{3}{2}}}{A^{\frac{1}{2}}} \quad \text{.....[V]}$$

approximately.

This formula gives the horse-power required by means of a propeller of radius r to maintain a steady pull or thrust of P lbs. If there are two or more propellers acting without the least interference, then their combined area is represented by $A = \pi r^2$.

In the formulas [III], [IV], and [V] r is the radius of the circle **equivalent in area** to the combined area of all the propellers.

The above case may be illustrated by a suspended frame carrying a motor and propellers with horizontal shafts in a yard or a large laboratory. The frame should be anchored by a cable attached to a spring balance, or, passing over a light and easily running pulley be attached to an adjustable weight P.

It is assumed that the propeller is correctly designed for the velocity v of the air current. For discussion of the design of the propeller see § 10.

Instead of a motor driving a horizontal shaft, one may use an electric motor and a vertical shaft, with arrangements for measuring the *lifting* or depressing effect of the propeller when in motion.

2. What is the Horse-power Required to Drive an Air-Ship in Still Air Against a Known Resistance P at the Rate of V Miles per Hour?

If all the air acted upon by the propeller be given an absolute velocity of v ft. per second, it is evident that the volume of air acted upon per second is now $A\ (v+v')$ in which v' is the velocity of the ship in feet per second.

To make this truth still more evident, it may be added that if we assume that the air-ship is drawn or towed thru the air by some other ship or motor, at the rate of v' ft. per second, our propeller standing still, the air would pass thru it, at the rate v' feet per second, or it would *appear* to do so, though really standing still. Now if the propeller be started and turned fast enough to press p lbs. per sq. ft. upon all the air passing, so as to give it an *absolute* velocity of v feet per second, then the *relative* or *apparent* velocity of the air passing thru the propeller would be $v+v'$ ft. per second, so that the volume of air acted upon every second would be $A\ (v+v')$.

A speed of V miles per hour is $\frac{22V}{15}$ feet per second.

$$\text{Hence } v' = \frac{22}{15}V. \text{ feet per sec} \ldots\ldots\ldots\ldots\ldots\ldots [\text{VI}]$$

The mass of the volume actually acted upon per second is $A\ (v+v^1)\frac{w}{g}$, and since the velocity imparted to this mass is v, the kinetic energy generated in the air-current per second is

$$\frac{Awv^2}{2g}(v+v') = \frac{Awv^3}{2g} + \frac{AwV^2v'}{2g} \ldots\ldots\ldots\ldots\ldots [\text{VII}]$$

The first term of this result is identical with the value of $K.\ E.$ given in equation [IV], and its value is accordingly $\frac{16}{r}P^{\frac{3}{2}}$; the second term, $\frac{Awv'v^2}{2g}$, when we substitute for v^2 its value $\frac{2gP}{Aw}$ from [III], becomes Pv', which is exactly what should have been anticipated; viz: the work done per second in overcoming the resistance of the air to the motion of the ship. Accordingly the horse-power required for the ship *when in motion* is

$$H' = \frac{P}{550}\left(\frac{16\sqrt{P}}{r} + \frac{22V}{15}\right) = \frac{P\,(v + v')}{550} \ldots\ldots\ldots [\text{VIII}]$$

The atmospheric resistance of still air upon a moving ship is taken to be the same as the resultant action of moving air upon a stationary ship, the velocity in the two cases being the same. The general equation for such resistance is in pounds

$$P = C\pi R^2 V^2 \qquad [\text{IX}]$$

in which R is the radius of the maximum cross-section of the air-ship in feet; and V, as before, is the velocity of the ship in miles per hour. C is a coefficient dependent upon the shape of the ship and the nature of its surfaces. An approximate value of C for a cigar-shaped air-ship with fairly smooth surfaces is 0.002. An exact method of determining P would be to measure the pull on a cable when the ship is anchored against a steady wind blowing V miles per hour. Probably no two ships would yield the same value of C in formula [IX].

3. Discussion of Formula [V] for the Case of an Anchored Ship, with a Motor Driving a Propeller Whose Radius is r.

$$H = \frac{8P^{\frac{3}{2}}}{275r} = 0.0515\frac{P^{\frac{3}{2}}}{A^{\frac{1}{2}}}$$

For a given value of P it is seen that the horse-power required varies **inversely** *as the* **radius** of the propeller. This suggests the economy of large propellers, or of an increase in their number. There are of course practical objections to very large propellers, and also to a large number of propellers. I venture to suggest for a ship three propellers, one rather low at the stern, and one on each side, well forward, and higher up, abreast or above the

uppermost member of the frame truss. In these positions, the propellers would create currents which would not sensibly strike the motor frame and car, or any part of its rigging, and hence would not retard the ship.

With given propellers it is seen that the horse-power required for a greater value of P increases more rapidly than does the value of P. For example, if P is made four times as great, the horse-power required is eight times as great. If P is multiplied nine times, the H must be increased 27 times. If however the face area of the propeller, A, increases equally with P, then the horse-power required to pull (or lift) will increase exactly with P. This appears from the equation above since

$$\frac{H}{P} = 0.0515\sqrt{\frac{P}{A}} \quad \text{.....[X]}$$

If $\frac{P}{A}$ is kept constant, $\frac{H}{P}$ is also constant.

4. Discussion of Formula [VIII].

$$H' = \frac{8P^{\frac{3}{2}}}{275r} + \frac{Pv'}{550}.$$

If the value of P given in [IX], and the value of v' from [VI] be substituted in the above, it becomes

$$H' = \left[\frac{8\,(C\pi R^2)^{\frac{3}{2}}}{275r} + \frac{C\pi R^2}{375}\right] V^3 \quad \text{.....[XI]}$$

from which it appears that the horse power required to drive an air-ship increases with the *cube of its velocity*. If a certain horse-power with a certain arrangement of propellers will drive an air-ship 10 miles per hour, it will require 8 times as many horse-power to drive it 20 miles per hour.* This does not mean that the motor must make eight times as many revolutions per second, but the increased work of one revolution multiplied by the increased number of revolutions would involve just eight times as much mechanical work.

* It will be seen later that a propeller fitted to a certain speed of the ship and to the pressure p upon the yielding air, is not properly fitted to a different speed and a different backward pressure. It should also be remembered that while the value of the radius may be the same, the *pitch* of the helicoidal blades should be changed.

5. Discussion of [XI].

Given H', C, R, and r for a Given Ship and Motor, What Speed can it Attain in a Still Atmosphere?

Solving for V we have

$$V=\left(\frac{H'}{\frac{8\,(C\pi R^2)^{\frac{3}{2}}}{275r}+\frac{C\pi R^2}{375}}\right)^{\frac{1}{3}} \quad \ldots\ldots\ldots\ldots\ldots [XII]$$

6. Another Formula for V When We Know the Value P_1, for a Particular Velocity V_1, with a Given Ship with a Given Motor and Propellers:—

From [IX] we have

$$\frac{P}{P_1}=\frac{V^2}{V_1^2} \text{ or } P=\frac{P_1}{V_1^2}\cdot V^2$$

Substituting this value of P in [VIII] we have

$$H'=\frac{P_1}{550\,V_1^2}\left(\frac{16\sqrt{P_1}}{V_1 r}+\frac{22}{15}\right)V^3 \quad \ldots\ldots\ldots [XIII]$$

whence

$$V^3=\frac{550V_1^2\,H'}{\left(\frac{16\sqrt{P_1}}{V_1 r}+\frac{22}{15}\right)P_1} \quad \ldots\ldots\ldots\ldots\ldots [XIV]$$

The utility of this formula may be shown by substituting known values for P_1, V_1, r, and H'. Thus, suppose P_1 is known to be 650 lbs. when $V_1=15$ (miles per hour), then [XIV] gives for a 85.5 horse-power motor and a propeller area, $A=206$ sq. ft. $=\pi\,(8.1)^2$

$$V^3=\frac{(550)\,(15)^2\,[60]}{\left(\frac{16\sqrt{650}}{15\times 8.1}+\frac{22}{15}\right)650}$$

whence $V=13.3$ nearly.

That is to say, a complete mechanism consisting of propellers and a 60 horse-power motor, which when anchored can produce a thrust of 650 lbs.—that being the thrust required when a certain air-ship is moving 15 miles per hour — can actually drive that air-ship only 13.3 miles per hour, unless the limit of 60 horse-power is exceeded.*

7. Numerical Results.

The following table is of value in estimating the power required with propellers of various sizes for **pulling** or **lifting** different amounts *when the frame is anchored in still air*. The propellers are supposed to be ideally perfect in design and construction, and no allowance is made for cross currents and for friction.

TABLE SHOWING HORSE-POWER WHEN P THE THRUST, PULL OR LIFT, AND THE RADIUS OF THE PROPELLER, OR THE TOTAL PROPELLER AREA ARE GIVEN.

P = pull or lift in lbs	r = radius of equivalent propeller in ft.	A = total area of all propellers in sq. ft.	H = horse-power required
† 1	1	3.14	0.029
4	1	3.14	0.23
100	1	3.14	29.00
1	5	78.53	0.006
100	5	78.53	5.8
400	5	78.53	46.4
400	10	314.12	23.2
650	8.1	206.00	59.5
900	10.4	339.93	75.5

* Throughout this paper I mean by one "horse-power" 550 foot-lbs. of real "work" per second, I make no use of a so-called "nominal horse-power."

† In a recent number of "Motor" (London), Mr. Rankin Kennedy says: "It would be a simple matter to prove by calculation that the power required of a propeller to sustain one pound weight in the air is 0.03 B.H.P. In any case, theoretically, 0.03 B.H.P. must be allowed for every pound weight to be lifted." Mr. Kennedy then goes on to say, that it would take only 12 HP. to lift or sustain 400 lbs.! The statement is dangerously loose. It would be true only on condition that the effective area of the propeller be also increased 400 times! With the *same propeller*, it would take 240 horse power to lift his 400 pounds! See Formula [X].

8. Numerical Applications of Formula [VIII].

$$H' = \frac{P}{550}\left(\frac{16\sqrt{P}}{r} + \frac{22V}{15}\right) = \frac{P}{550}\left(28.35\sqrt{\frac{P}{A}} + \frac{22V}{15}\right)$$

P means the resistance of still air to the motion of an air-ship, moving V miles per hour, determined by experiment or calculated by means of formula [IX].

P	V	r feet	A sq. ft.	H'
100	10	10	314.16	5.58
100	15	5	78.54	9.8
650	15	8.1	206.—	85.5
400	20	10	314.16	44.51
900	30	10	314.16	150.5
1000	60	20	1256.64	206.—

The above six cases apply to six different air-ships. The third is approximately that of Mr. Wellman, judging from the data he has published.

9. In the discussions of this paper, I have made no attempt to approximate the loss of energy due to friction in the mechanism, or to the friction of the air upon the blades; or that due to defective design; or to the impact of the propeller current upon the frame-work, its contents and connections.

Neither have I allowed for the energy spent fruitlessly upon diverging currents of air. To prevent, or rather to utilize such currents, I propose a short and thin enclosing cylinder for each propeller, with a slightly-flaring forward end.

I am preparing to experiment upon "lifting" fans (with vertical shafts) of various radii and various numbers of blades, and with enclosing cylinders of various lengths.*

* I learn from my friend, Dr. Octave Chanute, that experiments with enclosing cylinders have been made in Europe, but I have no access to their results.

Meanwhile, my formulæ are published in the hope that others may find the best designs for the entire mechanism, and the several coefficients of efficiency.

10. Characteristics of the Ideal Propeller.

1. The radius must be as large as is practicable.
2. The blade surfaces must be parts of right helicoids (*i. e.* like the bearing surfaces of a square-threaded screw).
3. Every blade must run to the central hub with *full depth.*
4. The "pitch" of the screw surface must be determined by the speed of rotation of the shaft and the velocity of the air through the propeller.

For Example: suppose the air-ship frame be anchored, and that the required thrust, or pull, of the propeller is 100 lbs., and the radius of the propeller be 8 ft.

Then $A = 201$

$$p = \frac{P}{A} = \frac{100}{201}$$

$$v = \sqrt{\frac{2g\,p}{w}} = \frac{80}{\sqrt{Aw}} = 20 \text{ nearly.}$$

That is, the backward current of air passing the propeller must be 20 ft. per second. If T be the revolutions per second and s the pitch of the screw we have $Ts = v = 20$ in the case assumed.

As T is generally known for a motor doing its maximum work we have

$$s = \frac{v}{T} = \frac{20}{T}$$

If T be 4, we have the pitch = 5 feet, if the ship is anchored.

If now the air-ship is moving 15 miles per hour, we have $v' = 22$, so that the air passes the propeller at the rate of $20 + 22$ ft. per second. Hence the pitch of the helicoidal blades must be

$$s = \text{pitch} = \frac{v + v'}{T} = \frac{42}{4} = 10\tfrac{1}{2} \text{ feet.}$$

If there are six blades, the depth of each should be 1.75 ft., or 21 inches, and each should subtend a circular arc of 60°.

The general formula for the pitch of the propeller of an airship is

$$s = \frac{\frac{16}{r}\sqrt{P} + \frac{22V}{15}}{T} \quad \text{.....[XV]}$$

in which V is the speed of the ship (in still air) in miles per hour; P is the resistance to the ship's motion (or the thrust of the propeller); r is the radius of the propeller; and T is the number of revolutions of the propeller per second.

All helicoidal surfaces should be as accurate and as smooth as possible on both sides of the blades.

It seems reasonable that the number and axial depth of the blades should be such that no air would pass the propeller without being directly acted upon by the propeller, in other words the projection of all the blades on a plane normal to the axis should make a complete circle. That is however a matter to be experimented upon.

It is hardly necessary to add that if there are two or more propellers, the pitch of the blades should in every case be $\frac{v + v'}{T}$ in which the values of T and v may not be the same for all propellers.

While the ideally perfect propeller should be suited to a given set of conditions, it is reasonable to adopt as the given conditions those which obtain when the motor is making its regular working maximum effort.

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Transactions of the Academy of Science of St. Louis.

VOL. XVIII. No. 2.

THE AMPHIBIANS AND REPTILES OF ARKANSAS.

JULIUS HURTER AND JOHN K. STRECKER, JR.

Issued May 14, 1909.

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Continued on page 3 of Cover.

THE AMPHIBIANS AND REPTILES OF ARKANSAS.*

JULIUS HURTER AND JOHN K. STRECKER, JR.

The present list of Arkansas amphibians and reptiles has been compiled with a twofold purpose in view: (1) to place on record a number of species collected by the senior author, which have not been reported from the state previously; (2) to form as complete a list of these animals as our present imperfect knowledge of the herpetology of the state will permit.

In the United States National Museum Collection are a number of specimens obtained by Marcy, Shumard and other members of the Red River Expedition. Some of these are labeled "Red River, Ark.," and "Fort Towson, Red River, Ark.," but were not collected within the limits of the present State of Arkansas.

Such species as *Bufo cognatus* Say, *Thamnophis marciana* B. & G., *Heterodon nascius* B. & G., and *Crotalus confluentus* Say are members of an entirely different faunal region and are not likely to range east of central Oklahoma. Ruthven† has called attention to the fact that Oklahoma examples of *Thamnophis radix* B. & G. are hard to distinguish from *T. marciana*. Examples of *marciana* from north-central Texas are not typical, and it is extremely doubtful whether this snake occurs north of Texas.

Fort Towson is situated in southeastern Oklahoma. Probably all of the species collected at this station will ultimately be found in southwestern Arkansas.

We have made liberal use of the Fort Smith records in a paper by Robert Baird McLain, entitled, "Notes on a

* Presented to The Academy of Science of St. Louis, March 1, 1909.

† Bull. U. S. Nat. Mus. 61: 69. 1908

Collection of Reptiles Made by Mr. C. J. Pierson at Fort Smith, Arkansas, with Remarks on Other Eastern Reptiles." (Wheeling, W. Va., 1899. Published by the author.) McLain's notes are based on specimens presented to the museum of the Leland Stanford Junior University. We must either doubt some of his identifications or else believe that some of Pierson's material was incorrectly labeled as to locality, for it seems hardly possible that such species as *Clemmys insculptus* LeConte, *Testudo polyphemus* Daudin and *Thamnophis sackeni* Kenn. should occur so far out of their natural range.

We are indebted to Dr. Seth Eugene Meek of Chicago for a list of material collected at several stations in Arkansas. This material is a part of the herpetological collection of the Field Museum of Natural History. Mr. Hurter takes this method of thanking Mr. John R. Fordyce, of Little Rock, for assistance rendered him in collecting material, as well as for other courtesies.

We did not deem it necessary to append a bibliography for the reason that in most of the literature at our disposal the Arkansas fauna is referred to in only a general way and furnishes very little authentic data.

A careful perusal of Marcy's "Report on the Red River Expedition" resulted in more eliminations than additions to our original list. The lists of specimens in Cope's "Crocodilians, Lizards and Snakes of North America," furnished us with some data, but much less than we had reason to expect, as this work is supposed to give a list of all of the specimens of these animals that were in the National Collection up to a short time prior to the author's death.

Most of the material collected by Hurter is in his private collection. The Combs lot is widely scattered, but examples of most of the species obtained by him are in the Hurter and Baylor University collections. The Hot Springs specimens in the National collection, secured through Messrs. H. H. and C. S. Brimley, were collected by Combs.

ARKANSAS LOCALITIES REFERRED TO IN THIS PAPER.

Locality.	Collector.	No. of Species.
Altus, Franklin Co.	Hurter	2
Arkadelphia, Clark Co.	Meek	1
Clarksville, Johnson Co.	Meek	1
Donaldson, Hot Springs Co.	Meek	1
Eureka Springs, Carroll Co.	Hurter	3
Fort Smith, Sebastian Co.	Eustis, Whipple, Shumard, Pierson	26
Fayetteville, Washington Co.	Meek	5
Greenway, Clay Co.	Meek	24
Hot Springs, Garland Co.	Combs, Hurter	37
Little Rock, Pulaski Co.	Hurter, Fordyce	18
Paragould, Green Co.	Hurter	14
Pine Bluff, Jefferson Co.	Hurter	7
Texarkana, Miller Co.	Hurter	4
Miscellaneous		9

From the foregoing table the reader can very readily see that we have definite records for only about fifteen out of the seventy-five counties in the State. Hot Springs, Garland County, furnished the largest number of species as a result of the work of two collectors. Combs spent nearly three years in this locality and obtained in all thirty-six species and sub-species. Hurter visited Hot Springs on two occasions, obtaining examples of seventeen species, only one of which had not previously been collected by Combs. At Fort Smith, the earlier collectors, Eustis, Shumard and Whipple, obtained six species that were not found there by Pierson in 1896-97. The results of Meek's work at Greenway, Clay County, and Hurter's at Paragould, Green County, furnish an interesting contrast as the two counties are adjoining. Meek collected twenty-four species, Hurter only fourteen, but the two lots contain representatives of thirty-six different forms, *Sceloporus undulatus* Lat. and *Ambystoma opacum* Gravenhorst being the only two species obtained by both collectors.

COMPARATIVE TABLE OF MISSOURI AND ARKANSAS REPTILES AND AMPHIBIANS.

	*Missouri.		Arkansas.†	
Amphibia				
Caudata	17		14	
Salientia	15	32	13	27
Reptilia				
Testudinata	17		14	
Ophidia	43		38	
Lacertilia	8	68	11	63
		100		90

* Based on Hurter's list (1907).
† The present list.

The following species have been recorded from Missouri, but not from Arkansas:

AMPHIBIA.

Cryptobranchus alleghaniensis Daudin
Plethodon erythronotus Green
Spelerpes maculicaudus Cope
Spelerpes longicaudus Green
Spelerpes stejnegeri Eignm.
Spelerpes guttolineatus Holbr.
Spelerpes melanopleurus Cope
Typhlotriton spelaeus Stejn.
Acris gryllus LeConte
Hyla versicolor LeConte
‡Hyla carolinensis Pennant
Rana sylvatica LeConte
Rana cantabrigensis Baird
Rana areolata circulosa R. & D.

REPTILIA.

Trionyx spiniferus LeSeur
Chrysemys cinerea Brown
‡Chrysemys bellii Gray
Terrapene carolina Linn.
Carphophis helenae Kenn. = C. amoenus Say
Coluber vulpinus B. & G.
‡Coluber spiloides D. & B.
Lampropeltis doliatus triangulus Cope
‡Storeria occipitomaculata Storer
‡Thamnophis radix B. & G.
‡Sistrurus catenatus Raf.
‡Zamensis constrictor flaviventris Say

The following species occur in Arkansas, but have not been recorded from Missouri:

AMPHIBIA.

Amphiuma means Linn.
Ambystoma annulatum Cope
Ambystoma jeffersonianum Green
Desmognathus brimleyorum Stejn.
Spelerpes multiplicatus Cope
Scaphiopus holbrookii Harlan
Chorophilus occidentalis B. & G.
Hyla squirella Daudin
Hyla versicolor chrysoscelis Cope

REPTILIA.

Anolis carolinensis Cuvier
Sceloporus consobrinus B. & G.
Cnemidophorus gularis B. & G.
Thamnophis eques Reuss
Tropidonotus leberis Linn.

Amphiuma means Linn., *Ambystoma jeffersonianum* Green, and *Scaphiopus holbrookii* Harlan probably range northward into the "sunken lands" of southeastern Missouri. *Ambystoma annulatum* Cope and *Desmognathus brimleyorum* Stejn. are at present known only from the State of Arkansas, and *Spelerpes multiplicatus* Cope

‡ These species may occur in western and southwestern Arkansas. An exploration of the caves of the Ozark Mountain region will probably disclose the presence of cave salamanders (*Spelerpes maculicaudus* and *S. longicaudus*). *Typhlotriton spelaeus* Stejn. may be discovered in some of the Ozark caves but the chances are against it. It has been collected in Barry and Stone Counties, Missouri, but in Carroll County, Arkansas, just across the line, Hurter failed to find any suitable caves.

from Arkansas and Oklahoma. *Cnemidophorus gularis* B. & G., *Sceloporus consobrinus* B. & G., *Thamnophis eques* Reuss, and *Hyla versicolor chrysoscelis* Cope are southwestern forms, whose range is extended to central Arkansas. *Chorophilus occidentalis* B. & G., *Hyla squirella* Daudin, and *Anolis carolinensis* Cuvier are typical Austroriparian species that are not likely to occur as far north as Missouri.

The following nineteen of the ninety species and subspecies of Arkansas amphibians and reptiles enumerated in this paper do not occur in eastern Texas:

AMPHIBIA.

Desmognathus brimleyorum Stejn.	Ambystoma jeffersonianum Green
Spelerpes multiplicatus Cope	Amphiuma means Linn.
Hemidactylium scutatum Schlegel	Necturus maculatus Linn.
Ambystoma annulatum Cope	Rana palustris LeConte
Hyla pickeringi Holbrook	

REPTILIA.

Chrysemys dorsalis Agass.	Tropidonotus sipedon sipedon Linn.
Chrysemys troosti Holbrook	Tropidonotus cyclopium D. & B.
Graptemys pseudo-geographica LeSeur	Coluber obsoletus confinis B. & G.
	Diadophis punctatus Linn.
Amyda mutica LeSeur	Carphophis vermis Cope

The majority of these are eastern and southeastern forms which find their western limit in Arkansas and the eastern half of Louisiana. Sixty-three of the seventy-one species and sub-species that occur in both Arkansas and the eastern half of Texas are also found in the State of Missouri.

The number of species known to occur in Texas at the present time is as follows:

Tailed amphibians	10*	
Frogs and toads	40*	
Turtles	22†	
Lizards	45†	
Snakes	70†	177

* Based on Strecker's List (Proc. Biol. Soc. Wash. 21 : 53–62) with addition of *Rana clamitans* which has since been found to occur in northeastern Texas.

† From Strecker's Check-List, which is now in press.

Deducting the Arkansas species found in eastern Texas (71) leaves 106 species. After carefully reviewing the work of recent collectors in eastern and northeastern Texas, we feel safe in saying that the greater per cent of future additions to the Arkansas list may be expected to come from the Austroriparian fauna of Louisiana and the Ozarkian fauna of southwestern Missouri rather than from the central of western Oklahoma and the Sonoran of Texas. Such forms as *Cnemidophorus gularis, Sceloporus consobrinus* and *Thamnophis eques* are merely outrunners from the Sonoran, whose relationships are not yet fully understood. Probably few true Sonoran species range east of the 98th meridian of longitude in Texas.

LIST OF ARKANSAS AMPHIBIANS AND REPTILES.

Class **Amphibia.**

Order CAUDATA.

Family Pleurodelidae.

1. Diemyctylus viridescens Rafinesque. Newt or Red Eft.

Southern Missouri, eastern Oklahoma, northern Louisiana, and northeastern Texas. No definite localities for Arkansas, but it probably inhabits the entire State.

Family Desmognathidae.

2. Desmognathus brimleyorum Stejn. Brimley's Salamander.

This species is abundant in the type locality, Hot Springs (Combs and Hurter) and at Little Rock (Hurter). At Little Rock Hurter placed examples of this species and *Spelerpes multiplicatus* Cope in the same bucket just as he captured them. On returning to his room, he discovered that the *Spelerpes* had all been devoured by the hungry *Desmognathus*.

Dr. O. P. Hay in "The Reptiles and Batrachians of Indiana" (p. 452) records *Desmognathus fusca* Hald. from southwestern Arkansas. His record was doubtless based on examples of *D. brimleyorum,* which was not described until some three or four years later.

Family Plethodontidae.

3. Spelerpes multiplicatus Cope. Many-ribbed Triton.

The types of this species (No. 4938 U. S. Nat. Mus. Coll. 4 examples, "Red River, Arkansas," Dr. L. A. Edwards, U. S. A.) were doubtless from some locality near the Red River in what is now eastern Oklahoma and not from within the limits of the present State of Arkansas. It is tolerably common at Little Rock (Hurter) and Meek obtained examples at Fayetteville.

4. Hemidactylium scutatum Schlegel. Scaly Salamander.

Hurter obtained two specimens of this species at Hot Springs. This makes the second record from west of the Mississippi River, the other locality being Bourbon, Crawford County, Missouri.

5. Plethodon glutinosus Green. Slimy Salamander.
Hot Springs (Combs), Little Rock (Hurter).

Family Ambystomidae.

6. Ambystoma annulatum Cope.

Four specimens of this rare salamander were collected at Hot Springs (Combs). See Proc. U. S. Nat. Mus., 1894: 599; and Proc. Biol. Soc. Wash., 21: 85-88.

7. Ambystoma punctatum Linn. Spotted Salamander.
Greenway (Meek).

8. Ambystoma opacum Gravenhorst. Marbled Salamander.
Paragould (Hurter), Greenway (Meek).

9. Ambystoma microstomum Cope. Small-mouthed Salamander.
Fort Smith (Shumard. U. S. Nat. Mus. Coll.)

10. Ambystoma jeffersonianum Green. Jefferson's Salamander.
Greenway (Meek).

11. Ambystoma tigrinum Green. Tiger Salamander.
Fayetteville (Meek).

Family Amphiumidae.

12. Amphiuma means Linn. Congo Eel or Snake.
Pine Bluff (Hurter), Greenway (Meek), Little Rock (Hay).

Family Proteidae.

13. Necturus maculatus Linn. Water-dog or Mud Puppy.
A specimen from the Arkansas River, Arkansas, is in the U. S. National Museum Collection. It was collected by Shumard.

Family Sirenidae.

14. Siren lacertina Linn. Siren or Two-legged Eel.
Little Rock (Hurter and Fordyce), Greenway (Meek).

Order SALIENTIA.

Family Ranaidae.

15. Rana pipiens Schreber. Leopard Frog.
Fort Smith (U. S. Nat. Mus. Coll.), Little Rock (Hurter and Fordyce), Hot Springs (Combs), Greenway (Meek).

16. Rana clamitans Lat. Green Frog.
Hot Springs (Combs), Texarkana, Paragould and Little Rock (Hurter).

17. Rana catesbiana Shaw. Bull Frog.
Fort Smith (Shumard), Hot Springs (Combs).

18. Rana palustris LeConte. Swamp Frog.
This species occurs in the "sunken lands" of southeastern Missouri and in northern Louisiana, so we feel no hesitancy in including it in the list.

Family Engystomatidae.

19. Engystoma carolinense Holbrook. Carolina Toad.
Hot Springs (Combs), Greenway (Meek).

Family Hylidae.

20. Chorophilus occidentalis Baird.
Hot Springs (Combs).

21. Chorophilus triseriatus Wied. Three-striped Tree Frog.
This tree frog is a common species in Kansas, Missouri, Oklahoma, Louisiana and northeastern Texas.

22. Acris gryllus crepitans Baird. Western Cricket Frog.
Fort Smith (Shumard), Paragould (Hurter).

23. Hyla pickeringi Holbrook. Pickering or Peeping Frog.
Greenway (Meek).

24. Hyla squirella Daudin. Squirrel Frog.
Greenway (Meek).

25. Hyla versicolor chrysoscelis Cope. Western Chameleon Tree Frog.
Hot Springs (Combs and Hurter). All of the Arkansas Hylas of this type (*versicolor*) that we have examined are referable to this sub-species. All of these were collected in Garland County in the central part of the State. The typical sub-species probably occurs throughout eastern and northern Arkansas.

Family Bufonidae.

26. Bufo americanus LeConte. Common Toad.
Fort Smith (Shumard), Hot Springs (Hurter and Combs), Little Rock (Hurter), Clarksville and Greenway (Meek).

Family Pelobatidae.

27. Scaphiopus holbrooki Harlan. Hermit Toad.
Greenway (Meek).

Class REPTILIA.

Subclass Chelonia.

Order TESTUDINATA.

Family Chelydridae.

28. Chelydra serpentina Linn. Snapping Turtle.
Hot Springs (Combs), Paragould (Hurter), Pine Bluff (Hurter).

29. Macroclemmys lacertina Schweigger. Alligator Snapping Turtle.
Little Rock (Hurter), Greenway (Arkansas University Museum), Fort Smith (Pierson).

Family Cinosternidae.

30. Cinosternum louisianae Baur. Louisiana Mud Turtle.
Texarkana (Hurter).

31. Sternothoerus odoratus Lat. Musk Turtle or Stink Pot.
This turtle occurs in southern Missouri, Oklahoma and northeastern Texas.

32. Sternothoerus tristycha Agass.
A specimen of this species from Sevier County, Arkansas, is in the Baylor University Museum. It is indistinguishable from central Texas examples. Ditmars* gives the range of this species as "the southeastern portion of the United States—Florida to Texas," but Hurter has examples from as far north as Ozark County, Missouri.

33. Chrysemys elegans Wied. Cumberland Turtle.
Paragould (Hurter).

* The Reptile Book. N. Y., 1908.

34. Chrysemys dorsalis Agass.
Paragould (Hurter).

35. Chrysemys troosti Holbrook. Troost's Turtle.
Greenway (Meek).

36. Chrysemys texana Baur.
The range of this species extends from southwestern Missouri (Jasper and Newton Counties) south through western Arkansas and eastern Oklahoma to the Gulf of Mexico and the Rio Grande River. West in Texas to the Pecos. The specimens recorded from Hot Springs under the name of *Chrysemys concinna* are probably referable to this species. The material on which this record was based consisted of several very young examples, too immature for very satisfactory determination. Dr. Baur considered *C. texana* the western representative of *C. concinna,* from which, according to his diagnosis, it differed in many important characters.

37. Graptemys pseudo-geographica LeSeur.
Pine Bluff (Hurter).

38. Graptemys geographica *LeSeur.* Geographic Turtle.
We have examined specimens of this species from a number of localities in Missouri and Texas. It also occurs in the rivers of eastern Oklahoma.

39. Terrapene triunguis Agass. Three-toed Box Turtle.
Hot Springs (Combs and Hurter).

40. Terrapene ornata Agass. Painted Box Turtle.
Near Magnolia, Columbia County, Arkansas. (Carapace in Baylor University Museum).

Family Trionychidae.

41. Amyda mutica LeSeur. Leather Turtle.
Fort Smith (Pierson), Pine Bluff and Little Rock (Hurter).

Subclass **Squamata.**

Order LACERTILIA.

Family Iguanidae.

42. Anolis carolinensis Cuvier. Chameleon Lizard or Green Lizard.

Hot Springs (Combs and Hurter).

43. Crotaphytus collaris Say. Bull Lizard or Collared Lizard.

Fort Smith (Whipple and Pierson), Fayetteville (Meek), Eureka Springs (Hurter), Little Rock (Fordyce).

44. Sceloporus undulatus Lat. Fence Lizard.

Little Rock and Paragould (Hurter), Greenway (Meek), Fort Smith (Pierson).

45. Sceloporus consobrinus B. & G. Marcy's Fence Lizard.

Monilton (F. C. Test, U. S. Nat. Mus. Coll.) This is a common species at Hot Springs, where Combs and Hurter obtained large series. Combs collected examples of this lizard among rocks as well as on trees and fences.

46. Phrynosoma cornutum Harlan. Horned Toad.

Fort Smith (Shumard).

Family Anguidae.

47. Ophisaurus ventralis Linn. Glass or Joint Snake.

Fort Smith (Pierson, Eustis, and Shumard).

Family Teiidae.

48. Cnemidophorus gularis B. & G. Swift.

Hot Springs (Combs and Hurter).

Swifts from this locality are typical *gularis* and are fully as large as examples from west Texas and New Mexico.

49. Cnemidophorus sexlineatus Linn. Six-lined Swift.

Fort Smith (Whipple and Pierson), Fayetteville (Meek), Pine Bluff (Hurter).

Family Scincidae.

50. Lygosoma laterale Say. Ground Lizard.

Hot Springs (Combs and Hurter), Altus, Little Rock and Paragould (Hurter).

51. Plestiodon quinquelineatus Linn. Skink.

Fort Smith (Shumard and Pierson), Greenway (Meek), Little Rock (Hurter), Hot Springs (Combs).

52. Plestiodon anthracinus Baird. Coal Skink.

The specimens of this species from the Arkansas River (Woodhouse) in the National Museum Collection, may not have been collected in the State of Arkansas, but as the animal is without a doubt found throughout the entire Ozark region, we feel safe in listing it here. In the adjoining States, *P. anthracinus* has been collected in the following localities:

Missouri: Laclede County (Clark), Pevely, Jefferson County (Hurter).

Oklahoma: Fort Towson (Shumard).

Texas: Brazos River (Shumard).

Order OPHIDIA.

Family Colubridae.

53. Tropidonotus grahami B. & G. Graham's Queen Snake.

Paragould (Hurter).

54. Tropidonotus sipedon fasciatus Linn. Southern Water Snake.

Hot Springs (Combs), Texarkana (Hurter), Fort Smith (Pierson). *T. s. pleuralis* (Cope).

55. Tropidonotus sipedon sipedon Linn. Common Water Snake.

Greenway (Meek).

56. Tropidonotus sipedon transversus Hallowell. Woodhouse's Water Snake.
Hot Springs (Combs and Hurter), Texarkana (Hurter), Fort Smith (Pierson), Little Rock (Hurter). *T. s. erythrogaster* Shaw.

57. Tropidonotus rhombifer Hallowell. Holbrook's Water Snake.
Paragould (Hurter), Fort Smith (Pierson).

58. Tropidonotus cyclopium D. & B. Cyclop Snake.
Paragould (Hurter).

59. Tropidonotus leberis Linn. Brown Queen Snake.
Hot Springs (Combs and Hurter).

60. Thamnophis proximus Say. Ribbon Snake.
Hot Springs (Combs), Greenway (Meek), Little Rock (Museum of the Leland Stanford Junior University).

61. Thamnophis sirtalis Linn. Common Garter Snake.
Missouri, Louisiana, Oklahoma, northern Texas, but no definite records from Arkansas.

62. Thamnophis sirtalis parietalis Say. Rocky Mountain Garter Snake.
Hot Springs (Combs).

63. Thamnophis eques Reuss.
Hot Springs (Combs).

64. Storeria dekayi Holbrook. DeKay's Brown Snake.
Hot Springs (Combs and Hurter), Little Rock (Hurter).

65. Tropidoclonium lineatum Holbrook. Lined Snake.
Missouri, Kansas (Fort Scott), Oklahoma, Texas.

66. Haldea striatula Linn. Brown Snake.
Hot Springs (Combs), Texarkana (Hurter), Fort Smith (Pierson).

67. Coluber obsoletus Say. Black Snake.
Eureka Springs (Hurter), Fort Smith (Pierson).

68. Coluber obsoletus confinis B. & G. Red-headed Black Snake.

Fort Smith (Whipple). Type specimen of *C. loetus* B. & G. Brown considers this the same as C. spiloides B. & G., but we do not agree with him.

69. Coluber guttatus Linn. Spotted Snake.

Greenway (Meek).

70. Coluber emoryi B. & G. Emory's Snake.

A specimen of this species in the National Museum Collection is labeled "Arkansas." As the range of this snake includes Missouri, Kansas, Oklahoma and northern Texas, it may prove to be of common occurrence in the western half of Arkansas.

71. Pityophis sayi Schlegel. Bull Snake.

Strecker has a poorly preserved example of this species, which was collected near Mena, Polk County.

72. Zamenis flagellum Shaw. Coach-whip Snake.

Fort Smith (Pierson).

73. Zamenis constrictor Linn. Blue Racer.

Hot Springs (Combs), Little Rock (Hurter), Greenway (Meek), Fort Smith (Pierson).

74. Cyclophis aestivus Linn. Keeled Green Snake.

Hot Springs (Combs), Little Rock (Hurter), Greenway (Meek), Fort Smith (Pierson).

75. Liopeltis vernalis Harlan. Grass Snake.

Arkadelphia (Meek).

76. Diadophis punctatus Linn. Ring-necked Snake.

Greenway (Meek).

77. Diadophis regalis B. & G. Regal Ring-necked Snake.

Hot Springs (Combs and Hurter), Eureka Springs (Hurter). These are examples of the color variety *arnyi* (Kenn).

78. Lampropeltis doliatus Linn. Scarlet King Snake.
. Hot Springs (Combs and Hurter), Fort Smith (Pierson). The variety *gentilis* B. & G. occurs in western Louisiana, Texas, Oklahoma, and, in all probability, Arkansas.

79. Lampropeltis getulus holbrooki Stejn. Holbrook's King Snake.
Hot Springs (Combs and Hurter), Fayetteville (Meek), Pine Bluff (Hurter).

80. Lampropeltis calligaster Say. Evans's King Snake.
Greenway (Meek).

81. Carphophis vermis Cope. Western Ground Snake.
Little Rock (Hurter), Fort Smith (Pierson).

82. Farancia abacura Holbrook. Hoop Snake.
Greenway (Meek).

83. Virginia elegans Kenn. Virginia's Snake.
Missouri, Louisiana, northern Texas.

84. Heterodon platyrhinus Lat. Spread Head or Blowing Adder.
Greenway (Meek), Fort Smith (Pierson), Hot Springs (Combs), Altus (Hurter).

85. Tantilla gracilis B. & G. Graceful Tantilla.
Hot Springs (Combs and Hurter), Little Rock (Hurter), Fort Smith (Pierson).

86. Elaps fulvius Linn. Coral or Harlequin Snake.
A specimen from "Arkansas" (no definite locality) is in the National Museum Collection. Students of Baylor University from southwestern Arkansas have repeatedly identified *Elaps* from Texas as the same species of "red, yellow, and black snake" that occurs in their own part of the country.

Family Viperidae.

87. Ancistrodon contortrix Linn. Copperhead.

Hot Springs (Combs and Hurter), Greenway (Meek), Fort Smith (Pierson).

88. Ancistrodon piscivorus Lacepede. Cotton-mouth or Water Moccasin.

Hopedale (Hay), Fort Smith (Shumard and Pierson), Hot Springs (Combs), Paragould (Hurter).

89. Sistrurus miliarius Linn. Ground Rattlesnake.

Sans Bois Creek, Ark. (Jeffers. U. S. Nat. Mus. Coll.)

90. Crotalus horridus Linn. Timber Rattle Snake.

Hot Springs (Combs), Paragould (Hurter), Donaldson (Meek). A specimen of the eastern diamond rattlesnake (*Crotalus adamenteus* Beau., in the National Museum Collection, is labeled "Arkansas," but probably through error. *Crotalus horridus* is the prevailing form of large rattlesnake throughout Missouri, Arkansas, eastern Oklahoma, and northeastern Texas.

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THE MEXICAN FIBER AGAVES KNOWN AS ZAPUPE.

WILLIAM TRELEASE.

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Continued on page 3 of Cover.

THE MEXICAN FIBER AGAVES KNOWN AS ZAPUPE*.

By William Trelease.

During the last four years frequent mention has been made of an important addition to the agriculture of Mexico through the extensive cultivation of a new type of fiber plant, "zapupe," in the coast or piedmont region between Vera Cruz and Victoria. Much of the publicity given the new venture has resulted from the intelligent interest taken in it by Mr. A. J. Lespinasse, late Consul for the United States at Tuxpam in the State of Vera Cruz, who in December last predicted a yield of three or four million pounds of fiber for this year from existing plantations.

It has been recognized that the name zapupe applies to several more or less different forms of *Agave* bearing a resemblance to one another and to the "sisal" or "henequen" plants of Yucatan and the "mezcal" plants cultivated in the vicinity of Tequila, in western Mexico; and enough habit photographs have been reproduced in publications to indicate the accuracy of this general conclusion. The only botanists who are known to have examined the new fiber plantations, however, are Dr. R. Endlich, who in 1905 visited the plantations about Tuxpam, and the following year collected the "ixtle" of the Mirador hacienda and its wild representative; Dr. C. A. Purpus, who in 1906 visited the Mirador hacienda; and Mr. L. H. Dewey, of our national Department of Agriculture, who studied the zapupes of the plantations about Tuxpam and Victoria early in 1907.

Although the fiber of some of these plants has been used and the plants have been cultivated in a way by the Indians, for a very long time, extensive plantations seem to date from about 1901. There is no evidence that a ten-

* Presented before The Academy of Science of St. Louis, May 3, 1909.

able botanical name has yet been attached to any of them, though it remains to be shown how far the Vera Cruz fiber ascribed to *Agave Vera Cruz, A. mexicana,* etc., is of the zapupe class. As is natural, samples of *Bromelia* and perhaps other fibers have been called zapupe; but the scanty literature of the group, based mainly on the statements of Lespinasse, Dewey, Endlich and Nunn, is fortunately free from serious confusion except that resulting from the fact that few references to zapupe pertain to a single species of plant—though the "azul" is most commonly meant.

The popular names, aside from the general designation "Huasteca henequen" or "Tamaulipas henequen," applied to the zapupe forms are (1) "azul" or blue, (2) "cimarrón" or mountain, (3) "Estopier," the name of one of the planters, (4) "Huasteca," a geographic name, (5) "San Bernardo," (6) "Sierra Chontla," a geographic name, (7) "silvestre" or forest, (8) "Tantoyuca," a geographic or tribal name, (9) "Tepezintla," a geographic name, (10) "verde" or green, and (11) "Vincent," after one of the planters; and to these is to be added the name "ixtle" or "ixtle manso" used locally at the Mirador hacienda and about Jalapa.

As would be expected, several of these names are synonymous with others, but five clearly distinguishable forms occur: (1) the blue zapupe, "zapupe azul," "zapupe de Estopier," "zapupe de San Bernardo" or, *par excellence,* simply "zapupe"; (2) the Tepezintla zapupe, "zapupe de Tepezintla" or "zapupe de Vincent"; (3) the Mirador ixtle or "ixtle manso" of the Jalapa region, (not to be confused with the similarly named Yucatan plant, or the miscellaneous Tampico fiber); (4) the wild zapupe, "zapupe cimarrón," "zapupe silvestre" or "zapupe de Sierra Chontla"; and (5) the Tantoyuca or green zapupe, "zapupe de Tantoyuca," "zapupe de Huasteca" or "zapupe verde."

These appear to be botanical species rather than cultural varieties or races; and in spine characters fall into

three easily recognized groups, of which one contains the cultivated azul only; another the cultivated Tepezintla and "ixtle" forms and the wild plant of the eastern flanks of Mount Orizaba; and the third the cultivated Tantoyuca and the wild cimarrón forms. The first, as Mr. Dewey has recognized, appears to be of the alliance of the typical west-slope "Tequila" species, and opinions differ as to whether or not it possesses any indigenous representative on the east slope; the second group appears to be of the table-land and eastern slope and is represented among described species by *A. rubescens;* and the third group, though local, is evidently allied to some of the mezcal species grown in western Mexico.

Through the kindness of Señor Molina, Secretario de Fomento of the Mexican Republic, Consul Lespinasse, Mr. Dewey, Dr. Endlich, Dr. Purpus, Consul Millwood and Señor Vincent, I have for some time had material and data sufficient for the differentiation of these five zapupe species, but have refrained from publishing on them in the hope that further material might be secured from which they could be fully described. Their economic importance and the constant need of botanical names by which they may be designated, however, are such that, at Mr. Dewey's request, they are now named and briefly characterized from vegetative characters—in which respect they have not the distinction of faring worse than a majority of their congeners. For the opportunity to do even this, I cannot too warmly thank the correspondents above named—especially Consul Lespinasse, who first placed material in my hands, and supplemented it by many subsequent sendings, and Mr. Dewey, whose collections and field notes are invaluable.

The zapupe forms are at most short-stemmed plants with numerous uniformly spreading straight concave elongated-lanceolate very fibrous dull but smooth leaves, armed with a strong end spine and numerous marginal prickles. The most important cultivated types are known to be Euagaves and there is no reason for doubt that all

belong to this section of the genus. Notwithstanding the absence of adequate flowering material, enough fragments and remnants have been seen to warrant the belief that in floral characters they are somewhat intermediate between the Sisalanae and Tequilanae, more closely approaching the latter. Though the wild species seem to fruit freely, capsules appear to be rare on the cultivated forms, and, as with *A. sisalana,* statements that they never fruit are to be found. All appear to be freely bulbiferous after flowering, and thus to afford "pole plants" as well as offsets, by which they are propagated, being permanently set at about six-foot intervals after a preliminary stay in closer nursery plantation.

End spine acuminately tapering, triquetrously subterete, not grooved, convex to barely a little concave at base, polished, at length blackish chestnut: marginal prickles rather slender, gradually tapering or with abruptly widened or sublenticular bases: leaves glaucous. *A. Zapupe.*

End spine broadly triquetrous or nearly half round, obliquely flattened or broad-grooved to beyond the middle, sometimes with raised edges, or round-grooved on young leaves, polished, often turning gray.

Spine and prickles blackish: spine gradually tapering: prickles rather slender, gradually tapering; leaves gray-green. *A. rubescens.**

Spine and prickles red or brown: spine somewhat acuminately tapering: leaves green.

Prickles small and slender, from lenticular bases. *A. Lespinassei.*

Prickles heavy, deltoid below or tapering from wide bases. *A. Endlichiana.*

End spine gradually tapering, nearly terete, round-grooved often to or beyond the middle, rather dull below, reddish or rarely purplish brown, often turning gray.

Prickles heavy, from deltoid bases: leaves grayish. *A. aboriginum.*

Prickles rather slender, gradually tapering or from lenticular bases: leaves green. *A. Deweyana.*

Agave Zapupe n. sp.

Leaves rather dark green, persistently glaucous, striate, thin, gradually acute, 8–10×150–200 cm.: end spine from bright red-brown becoming nearly black, smooth and glossy, gently curved, obtusely a little triquetrous, acuminately and subacicularly pointed from a broad convex flattened or slightly concave base, somewhat produced ventrally into the green tissue, 4×15–25 mm., not decurrent: marginal prickles similarly colored, usually 15–30 mm. apart in the middle, reduced or wanting near the tip, 2–3 mm. long, slender, straight or mostly upcurved, gradually tapering or their bases

* See Rept. Mo. Bot. Gard. **18**: 254. *pl. 31–34.* (1907).

somewhat abruptly widened or occasionally lenticular, the intervening thin translucent margin nearly straight. Inflorescence 3–6 m. high, the upper third or half laxly ovoid-paniculate with outcurved-ascending branches. Flowers short-pedicelled, greenish: ovary 5–6×25 mm., fusiform, somewhat fluted above: tube conical, about 8 mm. long and wide: segments 4–5×20 mm.: filaments inserted nearly in the throat, about 35 mm. long. Capsules very infrequent, ovoid, neither stipitate nor beaked. Bulbils abundant, strongly maroon-dotted.

The blue zapupe, "zapupe azul," "zapupe de Estopier" or "zapupe de San Bernardo," largely cultivated in the vicinity of Tuxpam, V. C., etc., for its excellent fiber: unknown to botanists as a wild plant, possibly introduced from the Pacific slope and apparently related to the blue "mezcal de Tequila," *A. tequilana,* from which it differs in its ungrooved end spine, slenderer prickles and, apparently, less common seeding.

Specimens examined:—Plantations about Tuxpam, V. C. (*Dewey, 651,* Feb. 1907, "zapupe azul"—the type; *Endlich,* Nov. 1905, and July and October 1906, "zapupe;" *Lespinasse,* October 1905, "zapupe," May and June 1908, "zapupe azul," and July 1908, "zapupe de Estopier"; *Molina,* Jan. 1909, "zapupe") and the island of Juana Ramirez (*Vincent,* November 1908, "zapupe azul" or "Estopier").

Agave Lespinassei n. sp.

Leaves yellowish green, very slightly and transiently glaucous, fibrous-striate in wilting, rather thin, gradually acute, 6–7× about 150 cm.: spine red-brown, often turning gray in age, smooth, usually glossy, a little curved, broadly triquetrous below, acuminately pointed, obliquely wide-grooved or concavely-flattened, often with a low median keel, to beyond the middle, somewhat produced ventrally and dorsally into the green tissue, 5–6×30–35 mm., the raised border at its base decurrent on the margin for about the length of the spine: prickles similarly colored, usually 15–20 mm. apart in the middle, reduced or wanting near the tip, 1–2 mm. long, very slender, straight, recurved, or mostly upcurved, from lenticular bases, the intervening thin translucent margin often slightly repand. Inflorescence, flowers and fruit unknown. Bulbils green.

The Tepezintla zapupe, "zapupe de Tepezintla" or "zapupe de Vincent," cultivated with the preceding for its fiber, and yielding very good results on Juana Ramirez: unknown to botanists as a wild plant, but evidently

closely allied to the succeeding indigenous species and to the purple-spined *A. rubescens* of the adjacent table-land.

Specimens examined:—Plantations about Tuxpam, V. C. (*Lespinasse*, June 1908—the type, and May 1908, "zapupe de Tepezintla") and the island of Juana Ramirez (*Vincent*, March 1909, "Tepezintla" or "Vincent").

Agave Endlichiana n. sp.

Leaves from light to dark green, apparently transiently glaucous, 5–9× 80–125 cm. or more: spine garnet-colored to chestnut, becoming grayish, smooth and very glossy, somewhat flexuous, almost half-round below, acuminately pointed, obliquely round-grooved or concavely flattened, often with a low median keel, to beyond the middle, usually produced ventrally and dorsally into the green tissue, 4–5×15–30 mm., decurrent on the margin for nearly its own length: prickles bright garnet or chestnut-pointed, 10–20 or exceptionally 30 mm. apart in the middle, often continuing to the tip, about 3 mm. long, heavy, upcurved, gradually tapering, the intervening thin translucent margin straight or low-repand. Inflorescence and flowers unknown. Capsules obovoid, stipitate, 30×60 mm.,—adherent vestiges of the flowers showing that the filaments are inserted about the upper third of the tube.

The "ixtle" or "ixtle manso" of the coastwise slope of the Orizaba range (but not of Yucatan); occurring wild, in a rather shorter leaved form, and somewhat cultivated for its fiber.

Specimens examined:—About Huatusco, V. C. (*Endlich, 1160 b*—the type, of dark color, and *1160 a*, a paler form, both in March 1906, and young capsules, Sept. 1906, "ixtle"; *Purpus, iv.*), Chavarillo (*Chamberlain*, March 1908) and elsewhere about Jalapa (*Sloss*, 1909, "ixtle manso").

Agave aboriginum n. sp.

Leaves yellowish green, persistently somewhat gray rather than glaucous, scarcely striate, rather fleshy and acuminately pointed, 5–11×70–150 cm.: spine from brown becoming grayish, smooth, dull below, nearly straight and conical, round-grooved to the middle, 4×35–50 mm., often decurrent on the margin for its own length: prickles similarly colored, usually 20–35 mm. apart in the middle, continuing nearly to the tip, 5–8 mm. long, sometimes with intercalated smaller ones, heavy, upcurved, their deltoid bases 5–8 mm. wide and sometimes concave below, the intervening thick usually green margin nearly straight. Inflorescence unknown.

The wild zapupe, "zapupe cimarrón," "zapupe silvestre" or "zapupe de Sierra Chontla," of the region be-

tween Tampico and Vera Cruz, where it is spontaneous, has long been used by the Indians, and is now somewhat included in the fiber plantations.

Specimens examined:—Plantations about Tuxpam, V.C. (*Lespinasse,* June 1908, "zapupe silvestre"—the type, and May 1908, "zapupe cimarrón"; *Dewey, 653,* Feb. 1907, "zapupe de Sierra Chontla").

Agave Deweyana n. sp.

Leaves yellowish green, very lightly and transiently glaucous and sometimes transversely banded on the back, fibrous-striate in wilting, thin, gradually acute. 5–10× about 150 cm.; spine brown or occasionally somewhat purple-tinged, smooth, dull below, nearly straight and conical; round-grooved in the lower third, 3–4×15–40 mm., at length shortly decurrent on the margin: prickles similarly colored, 15–40 mm. apart in the middle, reduced or wanting toward the tip, 2–3 mm. long, slender, upcurved or inflexed, their bases somewhat lenticular, the intervening thin translucent margin nearly straight. Inflorescence 3–6 m. high, the upper half rather densely oblong-paniculate with somewhat upcurved branches. Flowers unknown. Capsules sparingly produced, (immature) ovoid-oblong, shortly stipitate and beaked, 25×35 mm.: seeds 6×8–9 mm., narrow-margined.

The cultivated green zapupe, "zapupe de Huasteca," "zapupe de Tantoyuca" or "zapupe verde" of the region between Tampico and Vera Cruz, where (unless this means the preceding) it is said to have been long grown by the Indians and is now being extensively planted for its fiber: unknown to botanists as a wild plant, but closely allied to *A. aboriginum* of the same region.

Specimens examined:—Plantations about Victoria, Tam. (*Dewey, 649*—the type, and *648* and *650*, Feb. 1907, "zapupe verde"), Tuxpam, V.C. (*Dewey, 652,* Feb. 1907, "zapupe verde"; *Lespinasse,* June 1908, "Tantoyuca zapupe") and the island of Juana Ramirez (*Vincent,* March 1909, "Tantoyuca"), and also cultivated at Reynosa, Tam. (*Kastelic,* June 1908—a specimen which suggests that *Agave rigida* of the lower Rio Grande* may possibly be this rather than *A. fourcroydes*).

* See Rept. Mo. Bot. Gard. **19**: 278. (1908),—"*A. rigida* Coulter."

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EXPLANATION OF ILLUSTRATIONS.

PLATES I–VI.

PLATE I.—Above, contrasted spines of the zapupe Agaves, two of each: reading downwards, *A. Zapupe*, *A. Deweyana*, *A. aboriginum*, *A. Lespinassei* and *A. Endlichiana*. Below, end spines and marginal prickles of *A. Zapupe*, from specimens furnished by Mr. Lespinasse. Natural size.

PLATE II.—*Agave Zapupe*. Above, panicle fragment, with withered flowers and one capsule (from a photograph furnished by Secretary Molina). Reduced. Below, young bulbils, from material furnished by Mr. Lespinasse. Natural size.

PLATE III.—Above, *Agave Lespinassei*, from specimens furnished by Mr. Lespinasse. Below, *A. Endlichiana*. Spines and prickles, from spontaneous material collected near Jalapa by Dr. Chamberlain. Natural size.

PLATE IV.—*Agave Endlichiana*. Above, young capsules, with the flower remnant from one of them opened, *Endlich, no. 1160 a*. Below, old capsules, *Purpus, iv*. Natural size.

PLATE V.—Above, *Agave aboriginum*. Below, *A. Deweyana*. Spines and prickles, from material furnished by Mr. Lespinasse. Natural size.

PLATE VI.—*Agave Deweyana*. Old panicles, one of them deformed, near Victoria (from a photograph taken by Mr. Dewey in February 1907). Reduced.

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THE FAUNA OF THE RESIDUARY AUBURN CHERT OF LINCOLN COUNTY, MISSOURI.

E. B. BRANSON.

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Continued on page 3 of Cover.

THE FAUNA OF THE RESIDUARY AUBURN CHERT OF LINCOLN COUNTY, MISSOURI*

E. B. Branson.

The silicified fossils which represent the fauna described in this paper occur in an exceedingly fine, porous, siliceous matrix, almost chalk-like in appearance. The masses of this siliceous material, which is evidently a decomposed chert, occur imbedded in a red residuary clay exposed in the gutters by the roadside, a short distance east of Auburn, Lincoln County, Missouri. In 1896, Dr. Stuart Weller collected some of these masses and the fossils have been removed from them in the museum.

Seventy species are here recognized in the fauna besides several species of crinoids (represented by the columns only), bryozoans and pelycopods too fragmentary to be referred to their proper genera. Of the species recognized, forty-three have been described, eleven are new and are here described for the first time, and sixteen are unidentified. Thirty-three of the old species are recorded in the Geological Survey of Minnesota, III., as occurring in the Minnesota region, and of these eighteen occur in the Stones River group, sixteen in the Black River, fourteen in the Trenton, three in the Utica, and four in the Richmond.

The presence of such species as *Dalmanella subaequata, Orthis tricenaria, Zygospira nicolleti,* and *Lophospira perangulata* in large numbers fixes the age of this formation as low in the Mohawkian. *Dalmanella testudinaria* and *Ctenodonta medialis,* not hitherto recorded from below the Black River, are well represented and *Hindia parva, Lichenaria typa, Carinaropsis phaleria, Carinaropsis acuta, Lophospira oweni,* and *Strosphostylus textilus,* not recorded elsewhere from below the Black River,

* Presented by title to The Academy of Science of St. Louis, March 18, 1907.

occur rarely here. A species identified as *Liospira micula* which has not been recognized below the Utica in the Minnesota region is abundant in this fauna and *Liospira progone* which is not reported from below the Trenton in Minnesota is represented by several specimens. From the evidence furnished by this fauna the beds containing it may be safely considered as pre-Trenton in age, but it is not entirely clear whether they should be correlated with the Black River or the Stones River.

Description of Species.

CTENODONTA AUBURNENSIS, n. sp.

Pl., vii. f., 2-4.

Shell small, four to seven millimeters in length, three to five millimeters in height, length behind umbones slightly greater than in front. Umbones prominent, beaks curved inward and directed forward. Base regularly convex or slightly flattened in the middle, antero-cardinal outline slightly concave, posterior umbonal ridge straight to slightly convex. Surface of shell marked with coarse, well defined lines of growth. Number of teeth eighteen, eight in front of the beaks. Teeth smallest near the beaks, wanting beneath the beaks. Denticles nearly parallel to a line drawn from the beaks through the greatest width of the shell.

C. auburnensis differs from *C. fecunda,* the nearest allied species, in being smaller, proportionally much longer in front of the beaks, narrower in proportion to the length, and the denticles pointing away from the beaks at a smaller angle.

This species is based on a large number of specimens. Number 11517 of the invertebrate paleontological collection of Walker Museum.

CTENODONTA COSTATA, n. sp.

Pl. vii. f. 7-8.

Shell small, subtriangular, length and height subequal, thickness about one-third the height, compressed near

ventral margin. Beaks prominent, recurved, situated anterior to center of shell. A sharply defined anterior cardinal sulcus extending from beaks to antero-ventral margin. Anterior to the beaks the hinge plate is long, slightly convex, provided with about eighteen short, strong, slightly curved or straight teeth. Teeth small near beaks. Posterior to beaks the hinge plate is shorter, straight, provided with about twelve teeth. These teeth are smaller than the largest teeth anterior to beaks. Ventral margin of shell nearly semicircular, convexity slightly increased where it passes into the posterior hinge line. Surface of shell marked with about eighteen strong concentric ridges. These are smallest and closest together near the beaks, strongest on middle third of shell.

C. costata resembles *C. similis* Ulrich in shape. Its long anterior sulcus resembles that of *C. recurva* Ulrich. It differs from these forms in the concentric ridges, being much more prominent and closer together and having no finer striae between, in the number of teeth being smaller, and the beaks being anterior to the middle of the shell.

This species is based on twelve well preserved specimens, one of which shows the dentition. Number 11503 of the invertebrate paleontological collection of Walker Museum.

MODIOLODON SUBRHOMBOIDEUS, n. sp.

Pl. vii. f. 1.

Shell small, subrhomboidal, height five to six millimeters, length along the hinge line three to four millimeters. Valves gibbous near the beaks. Posterior cardinal region compressed; beaks prominent, slightly incurved; hinge plate very thin, two small cardinal teeth in left valve, one small tooth at the posterior end of the hinge plate parallel with the hinge line. Anterior to the beaks is a small projection separated from them by an indistinct sulcus. The rest of the anterior margin of the

shell is slightly convex and passes downward at an angle of seventy-five degrees with the hinge line; lower margin strongly and evenly convex; posterior margin compressed, slightly convex, meeting the hinge line at an angle of one hundred twenty degrees. Surface of the shell marked with fine concentric lines, indistinct in casts.

M. subrhomboideus differs from *M. gibbous,* the nearest allied species, in having a tooth at the posterior end of the hinge plate, in the larger angle that the anterior margin of the shell forms with the hinge line, and in its rhomboidal shape.

This species is based on five fairly well preserved specimens. Number 11518 of the invertebrate paleontological collection of Walker Museum.

MODIOLOPSIS EXPANSA, n. sp.

Pl. vii. f. 5-6.

Shell small, length eight millimeters, greatest height five millimeters, about twice as high at the posterior end as at the beaks. Hinge plate long, straight, apparently edentulous. Anterior end of shell subangular, projecting fartherest at the ventral margin. Ventral margin convex anteriorly and posteriorly, concave in the middle, posterior margin convex, straightening slightly above where it passes backward to meet the hinge line. A deep sulcus passes downward and backward from the tip of the beaks meeting the ventral margin at about the middle of the shell. Surface of shell with concentric lines, not well preserved in the types which are casts. Anterior adductor scars large round and deep, occupying most of the shell anterior to the beaks.

M. expansa differs from *M. nana,* the nearest allied species in being much higher posteriorly, having a deeper sulcus, and the adductor scars being smaller and deeper.

The species is based on five fairly well preserved casts. They are number 11521 of the invertebrate paleontological collection of Walker Museum.

PARALLELODUS OBLIQUUS, n. gen. and sp.

Pl. vii. f. 9-10.

Shell obliquely subovate, strongly convex, maximum length observed forty millimeters, width half the length, widest at posterior end of hinge. Hinge plate nearly straight, about half the length of the shell. Beaks situated slightly in front of the middle of the hinge line. One tooth anterior and one posterior to beaks in right valve; two teeth anterior and two posterior to beaks in left valve. Teeth long, almost parallel to hinge line. The anterior margin of the shell curves abruptly downward from the hinge to the ventral margin, ventral margin moderately and evenly convex, posterior margin passing downward and backward in a nearly straight line to the ventral margin. Umbones prominent, curving inward over the hinge line. An umbonal ridge, prominent for half the length of the shell, extends backward to the postero-ventral margin. Surface of shell marked with rather coarse concentric striae, faintly impressed on casts. Muscular scars not traceable on casts.

This genus is characterized by its dentition and the position of its hinge. The shell closely resembles that of *Whiteavesia* in shape.

Genus based on several specimens, two of which show the dentition. Number 11534 of the invertebrate paleontological collection of Walker Museum.

CATASCHISMA TYPA, n. gen. and sp.

Pl. vii. f. 15.

Shell small, low, width and height subequal. Whorls four, increasing rapidly in size, lower whorl ventricose. Apical angle about ninety-five degrees. Umbilicus probably present. Lip with a shallow slit considerably below the middle of the whorl. Band obscure, broad, slightly depressed, entirely covered excepting on the lower whorl. Lines of growth not apparent. The slit is not at the summit of a ridge, the contour of the whorls being scarcely modified by its presence.

This genus is distinguished from all other Ordovician Pleurotomaridae by the shallow slit which occurs very low on the whorl. It differs from other slit-bearing forms in the shape of the shell, resembling *Cyclonema* in this respect.

Genus and species based on a single perfect specimen. Number 11552 of the invertebrate paleontological collection of Walker Museum.

HELICOTOMA MISSOURIENSIS, n. sp.

Pl. vii. f. 11-12.

Shell large, diameter twenty-seven millimeters, height fifteen millimeters. Whorls five, the upper two coiled in nearly the same plane, the others rising gradually. Upper surface of whorls sloping slightly toward the suture line, slightly convex in the middle, a decided furrow one-half millimeter outside the suture line. Outer surface of lower whorl convex below, concave above, outer surface of other whorls straight, sloping slightly outward. Lines of growth sigmoidal, outer ends curving strongly backward to the notch-carina. Notch-carina prominent, umbilicus small.

H. missouriensis agrees with *H. tennesseensis* save in having a furrow one-half millimeter outside the suture line and none at the suture line.

This species is based on a single well-preserved specimen. Number 11528 of the paleontological collection of Walker Museum.

LIOSPIRA, n. sp.

This species differs from *Liospira micula* in having a smaller apical angle, in having the suture well impressed, and in the whorls being slightly convex upward.

One specimen too imperfect for description is in the collection. Number 11549 of the invertebrate paleontological collection of Walker Museum.

HORMOTOMA LATIANGULARIS, n. sp.

Pl. vii. f. 13.

Shell very small, four millimeters high, three millimeters wide; apical angle fifty-seven degrees. Volutions five, increasing rapidly in size, lower volution forming considerably more than half of the shell. Band comparatively broad, slightly convex, the convexity giving to the upper volutions a subangular appearance. Notch shallow, slightly above the middle of the whorl. Lines of growth curved slightly backward on the upper side of the whorls.

Hormotoma latiangularis can be readily distinguished from all other species of *Hormotoma* by its wide apical angle, low spire, and convex band.

Species based on a single perfect specimen. Number 11552 of the invertebrate paleontological collection of Walker Museum.

HORMOTOMA FASCIATA, n. sp.

Pl. vii. f. 16.

Shell large, very loosely coiled, apical angle about sixteen degrees. Band narrow, convex, considerably elevated. Suture very deep, lines of growth coarse, bending strongly backward from the suture to the band. Aperture slightly higher than wide.

This species differs from *H. gracilis* in being more loosely coiled, having a very considerably raised band, the lines of growth bending backward more strongly, and the notch being deeper.

This species is based on two specimens. Number 11509 of the invertebrate paleontological collection of Walker Museum.

PTEROTHECA EXPANSA. Emmons.

Pl. vii. f. 14.

Emmons, Natural History of New York, 4:397, 1842.

A single specimen which is referred with some doubt to this species. It differs from the specimen figured by

Emmons in being regularly ovate, fifty millimeters long by seventy-five millimeters broad, and in the surface being plain on either side of the median fold. The specimen figured by Emmons seems to have been deformed by pressure applied from the sides.

HYOLITHES, n. sp.

This form differs from *H. baconi* Whitfield in the ventral surface being evenly convex instead of subangular.

The specimens in the collection are too fragmentary for description. Number 11532 of the invertebrate paleontological collection of Walker Museum.

PTERYGOMETROPUS LINCOLNENSIS, n. sp.

Pl. vii. f. 17-19.

General form elongate, slender, tapering gradually posteriorly. Cephalon subcresentiform, with a compressed, obtusely angular projection in front. Frontal lobe of glabella short and broad, proportion of length to breadth about six to seven. First lateral furrows reaching the dorsal furrows and separating the first lateral lobes from the frontal lobe. Inner ends of these furrows about two millimeters apart. Second lateral furrows very short and deeply impressed at their inner ends. First and second lateral lobes confluent at their outer ends. Third lobe of glabella very small and not confluent with the second lobe. Occipital ring prominent at the median line, projecting above the rest of the cephalon. It bears no tubercle. Frontal lobe and sometimes the first and second lateral lobes sparsely tuberculate. Eye elongate, reaching from the outer end of the first lateral furrow to the occipital furrow. Posterior part of fixed cheek very small and usually not preserved with the specimens. It bears no genal spine.

Thoracic segments eleven. Pygidium subtriangular. Pleura with eleven or twelve segments, one or two of the posterior ones indistinct; axis tapering gradually behind and reaching nearly to the posterior end of the

pygidium; segments about nineteen, posterior ones indistinct. Dorsal furrows concave inward.

Pterygometopus lincolnensis differs from *P. eboraceous* in the absence of genal spines, in the third lobe of the glabella not being confluent with the second, in the absence of a tubercle on the occipital ring, in the frontal lobe of the glabella being shorter and broader, in the greater length and slenderness of the axis of the pygidium, in the longer eye, and smaller fixed cheek.

It differs from *P. intermedius* in the shape of the first lateral furrow of the glabella, in the second lateral furrow not reaching to the dorsal furrow, in the length of the eye, and the more strongly tuberculate character of the frontal lobe of the glabella.

It differs from *P. schmidti* in the greater length of the cephalon, in the absence of tubercles on the free and fixed cheeks, in the shape of the anterior part of the cephalon, in the absence of genal spines, and in the confluence of the first and second lateral lobes of the glabella.

Species based on several specimens of heads and pygidii, and one almost complete specimen. Numbers 11484 11554 of the collection of invertebrate fossils of Walker Museum.

PTERYGOMETROPUS INTERMEDIUS Walcott.

Pl. vii. f. 20.

The specimens referred to this species differ from the type and from those described by Clarke, in the genal spines reaching to the fifth or sixth thoracic segment and in the cephalon being nearly cresentiform.

TECHNOPHORUS BELLISTRIATUS, n. sp.

Pl. vii. f. 21.

Shell small, length fifteen millimeters, height nine millimeters, slightly higher anterior to beaks than posterior. Beaks situated about one-third the length of the shell from the anterior extremity, projecting about two millimeters above the hinge plate. Posterior to the beaks the

hinge line is gently concave, anterior to the beaks the shell is imperfect and the characters of the hinge can not be made out. Anterior margin regularly rounded from the extremity of the hinge line to the basal margin, basal margin convex anteriorly but becoming nearly straight near the posterior extremity of the shell. A sharp narrow ridge extends from the beaks to near the postero-basal angle of the shell, its most prominent part descending at an angle of thirty-eight degrees with the hinge line. Near the beaks the ridge is almost straight and very low, but it increases in height as it passes downward and backward. For the lower two-thirds of its length it is high sharp, and convex upward. Anterior to this ridge is a narrow sulcus which begins about three millimeters from the beaks and increases in depth and width as it passes downward. Posterior to the ridge is a broad sulcus slightly arched over by the ridge. On the anterior two-thirds of the shell the surface is marked with fine concentric lines. At the anterior edge of the sulcus in front of the ridge these lines meet coarser lines of the sulcus at an angle of about eighty degrees. Posterior to the ridge short, ill-defined lines descend into a sulcus where they meet at a sharp angle lines passing downward and backward from the hinge line.

This species differs from *Technophorus divaricatus,* the nearest allied species, in being proportionally much broader, in the sulcus anterior to the ridge being narrower and starting from a point posterior to the beaks, in the ridge being sharper, concave upward, arched over the posterior sulcus, and forming a greater angle with the hinge line.

This genus has usually been classed with the pelycopods, but the characters of the hinge are very different from those of any known pelycopod and it should probably be classed with the bivalve crustaceans.

Species based on a single well preserved specimen. Number 11551 of the invertebrate paleontological collection of Walker Museum.

The following table gives the geological and geographical occurrence of the species that constitute the fauna described in this paper. It is copied with slight modification from Volume III, part II of the Geological Survey of Minnesota. The first five columns give the occurrence of the species in the formations of the Minnesota region, and the last four columns give their occurrence in the Cincinnati, Tennessee, New York and Canadian regions. The abbreviations are S, Stones River; B, Black River; T, Trenton; U, Utica; L, Lorraine; R, Richmond.

The writer is under obligations to Dr. Stuart Weller, under whose directions these investigations were made, for the privilege of using the material in Walker Museum, for checking up the identifications, and for many valuable suggestions.

	Trenton Period			Hudson River Period					
	Stones River Group	Black River Group	Trenton Group	Utica Group	Richmond Group	Cincinnati Region	Tennessee Region	New York Region	Canada Region
PORIFERA, COELENTERATA AND BRYOZOA									
Hindia parva? Ulrich		×	×			T	T		
Streptelasma corniculum? Hall			×					T	T
Lichenaria typa? W. and S.		×				B			
Rhinodictya sp. undet									
BRACHIOPODA									
Dalmanella subaequata Conrad	×					S	S		BT
Dalmanella testudinaria Dalman		×	×	×	×	BR	TH	BtoH	B–H
Lingula sp. undet									
Orthis tricenaria Conrad	×	×	×			SBT	SB	T	BT
Strophomena incurvata Sheppard	×	×				SBT	S	T	BT
Zygospira recurvirostra Hall	×	×	×			SBT	ST	T	BT
Zygospira nicolleti W. and S.	×								
PELECYPODA									
Ctenodonta auburnensis n. sp.									
Ctenodonta costata n. sp.									
Ctenodonta medialis Ulrich		×							
Ctenodonta nasuta Hall	×	×					SB	T	BT
Ctenodonta oviformis Ulrich			×						
Ctenodonta n. sp.						S			
Cyrtodonta billingsi Ulrich	×								
Cyrtodonta sp. undet									
Goniophora carinata Conrad								T	
Modiolodon subrhomboideus n. sp.									
Modiolopsis expansa n. sp									
Modiolopsis sp. undet									
Parallelodus obliquus n. gen. and sp.									
Psiloconcha? sp. undet									
Rhytima sp. undet									
Sphenolium sp. undet									
Whiteavesia subcarinata Ulrich			×				T		
GASTROPODA									
Archinacella patelliformis Hall								T	
Archinacella sp. undet									
Carinaropsis actua U. and S.		×							
Carinaropsis phaleria Sardeson		×							
Cataschisma typa n. gen. and sp.									
Conradella fimbriata U. and S.	×								
Cyrtolites retrorsus Ulrich						TU			

	Trenton Period			Hudson River Period		Cincinnati Region	Tennessee Region	New York Region	Canada Region
	Stones River Group	Black River Group	Trenton Group	Utica Group	Richmond Group				
GASTROPODA—*Con'd*									
Bellerophon capax Ulrich						UL			
Bucania halli U. and S.	×					B			
Eotomaria dryope Billings	×						B		B
Helcionopsis sp. undet									
Helicotoma missouriensis n. sp.									
Helicotoma tennesseensis Safford									
Holopea insignis U. and S.	×						S		
Hormotoma fasciata n. sp.									
Hormotoma gracilis v. *sublaxa* Hall									
Hormotoma latiangularis n. sp.									
Liospira micula Hall				×	×	TULR			
Liospira progone Billings			×			BT	ST		BT
Liospira n. sp.									
Lophospira fillmorensis Ulrich			×						
Lophospira obliqua Ulrich			×		×	SBT			
Lophospira oweni U. and S.		×				BU			
Lophospira perangulata Hall	×					S	S	S	B
Lophospira saffordi Ulrich							T		
Pterotheca expansa Emmons								T	
Pterotheca sp. undet									
Strophostylus textilis U. and S.		×	×				T		
CEPHALOPODA									
Cyrtoceras billingsi Salter	×					S			B
Cyrtoceras sp. undet.									
Orthoceras bilineatum Hall	×	×				B	T	T	BT
Orthoceras sociale Hall			×	×	×	UL			
TRILOBITA									
Bathyurus spiniger Hall	×					S		T	BT
Bumastus trentonensis Emmons	×	×	×			S		BT	BT
Ceraurus pleurexanthemus Green	×	×	×			ST	S	T	B–H
Isotelus iowensis D. D. Owen									
Pterygometopus lincolnensis n. sp.									
Pterygometopus intermedius Clarke	×	×				S			
Ptychopyge sp. undet.									
OSTRACODA									
Primitia n. sp.									
Primitia n. sp.									
Relationships uncertain									
Technophorus bellistriatus n. sp.									

EXPLANATION OF ILLUSTRATIONS.

Plate VII.

1, *Modiolodon subrhomboideus*, ×3.—2–4, *Ctenodonta auburnensis*, ×3, an oblique view to show hinge-teeth.—5–6, *Modiolopsis expansa*, ×3.—7–8, *Ctenodonta costata*, ×3.—9–10, *Parallelodus obliquus*.—11–12, *Helicotoma missouriensis*, 11, ×1½.—13, *Hormotoma latiangularis*, ×3.—14, *Pterotheca expansa*, Emmons.—15, *Cataschisma typa*, ×3.—16, *Hormotoma fasciata*, ×1½.—17–19, *Pterygometopus lincolnensis*, ×2.—20, *Pterygometopus intermedius* Walcott, ×2.—21, *Technophorus bellistriatus*, ×2.

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NEW NORTH AMERICAN ACARINA

H. E. EWING.

Issued, August 16, 1909.

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Continued on page 3 of Cover.

NEW NORTH AMERICAN ACARINA.

H. E. EWING.

INTRODUCTION.

In this country little has been done upon the general study of Acarina. Most of the work which has been done is upon special families or groups, or upon those species which have an especial economic importance. Mr. Nathan Banks has made a somewhat general study of our mites and has described many species from different parts of the country. In his "Treatise on the Acarina, or Mites," Proc. U. S. Nat. Mus. **28**: 1–114, he reviews the work done on the Acarina in our country and gives excellent keys to our genera.

Up to the present time about 500 species of the order Acarina have been recorded from America, most of which are referable to European genera. It may be that a study of the subtropical or arctic mites will reveal several new genera peculiar to our continent; of the former, especially, scarcely anything is known up to the present.

The writer is indebted to the following persons for the collection of many of the specimens used in the following descriptions: Mr. C. R. Crosby, assistant entomologist, New York State College of Agriculture; Mr. J. D. Hood of the University of Illinois; Mr. C. A. Hart, systematic entomologist of the Illinois State Laboratory of Natural History; Mr. E. O. G. Kelly, ex-assistant to the State Entomologist of Illinois; and L. M. Smith, assistant to the State Entomologist.

Dr. J. W. Folsom has aided the writer in several ways and Dr. S. A. Forbes has offered him all the privileges of the Illinois State Laboratory of Natural History. In this laboratory type specimens have been deposited.

In this paper 32 species are described, which are distributed in 14 genera and 7 families. The arrangement into genera and families is as follows:

CHEYLETIDAE
Cheyletus ..... 1 species.

RHYNCHOLOPHIDAE
Rhyncholophus..... 9 species.
Smaris ..... 1 species.

TROMBIDIIDAE
Trombidium..... 2 species.

GAMASIDAE
Macrocheles ..... 2 species.
Laelaps ..... 3 species.

GAMASIDAE
Hyletastes..... 1 species.
Gamasus ..... 3 species.

UROPODIDAE
Uropoda..... 5 species.
Uroseius..... 1 species.
Dinychus..... 1 species.

ORIBATIDAE
Oribata ..... 1 species.

TYROGLYPHIDAE
Tyroglyphus..... 1 species.
Rhizoglyphus..... 1 species

DESCRIPTION OF SPECIES AND HIGHER GROUPS.

CHEYLETIDAE.

Body divided into cephalothorax and abdomen; last segment of palpus transformed into a papilla, while the penultimate ends in a large claw; without eyes; leg I ending in several long hairs. Usually predaceous in habits, but sometimes parasitic.

CHEYLETUS Latreille.

Body longer than broad but never twice as long as broad; palpi swollen on the outer side near the base; hind legs provided with claws; papilla of palpus having at least one specialized comb-like bristle. Seldom parasitic, generally predaceous.

One species.

Cheyletus longipalpus n. sp.

Pl. VIII. f. 1.

Light orange; legs and palpi lighter than the body; integument coarsely granular.

Cephalothorax slightly larger than the abdomen and possessing four rows of large, pectinate, fan-shaped scales; two rows of five scales each near the median line and two lateral rows of four scales each. Total length of the beak almost equal to the length of the rest of the cephalothorax; beak with a base much swollen dorsally and possessing a pair of small, straight bristles near the tip on the dorsal surface and a similar pair situated laterally to these. Palpi long, being a third longer than the beak. First segment of palpus small, disc-like; second segment enormous, long, curved, about equal to the total length of the

beak and possessing a long digit at its distal end on the inner dorsal aspect, from which springs a stout, pectinate bristle slightly longer than the digit itself; third segment short, as broad as long and with a prominate, stout, pectinate bristle on its outer margin, about twice as long as the segment itself; distal segment ending in a large, simple claw about twice as long as the segment itself, and with a single bristle on its inner margin; papilla small and bearing two slightly curved serrulae, the outer of which is slightly the longer, and two somewhat longer and more strongly curved, simple bristles. The outer serrula is about three-fourths as long as the claw of the distal segment.

Abdomen short; possessing four rows of scales similar to those of the cephalothorax; three scales in each of the two inner rows and four in each of the outer rows.

The anterior pair of legs is very much elongated, being longer than the body of the mite and about twice as long as the second pair. Tarsus of leg I about two-thirds as long as the tibia, swollen distally and terminated by two long bristles both of which are longer than the segment itself, the inner being slightly the longer. The tarsus of leg I bears no scales, all the other segments of leg I bear one or more large scales similar to those of the body. Tibia of leg I one and a half times as long as the genual. Claws of the last three pairs of legs moderate, situated on stout pedicels.

Length, 0.32 mm.; breadth, 0.22 mm.

Under a log. Collected by the writer at Urbana, Ill.

RHYNCHOLOPHIDAE.

Last segment of palpus transformed into a thumb, penultimate segment ending in a claw; mouth parts often retractile. Cephalothorax and abdomen on the same plane with frequently no division between the two; dorsal surface of cephalothorax with a long median groove which usually ends in a tubercle at its anterior end. Eyes sessile, sometimes six pairs present.

This family is rich in species, most of which are found in grass or upon the leaves of trees.

RHYNCHOLOPHUS Dugés.

Mouth parts not retractile; palpi of five segments; no eyes situated on the anterior margin of the cephalothorax.

Nine well-characterized species.

KEY TO SPECIES.

1. Body elongated and strongly constricted at the insertion of the hind group of legs; setae of the body in the form of tridents *R. tridentifer.*

   Body shorter, if constricted at the insertion of the posterior group of legs, but slightly so; setae of body not forked 2.

2. Legs very long, hind pair at least twice as long as the body 3.
   Legs much shorter, hind pair never one and a half times as long as the body 4.
3. Thumbs enormously swollen, being much broader than segment four of the palpus *R. pollicaris.*
   Thumb moderately swollen, equal to segment four in width *R. parvisetosus.*
4. Palpi twice as long as the mandibles 5.
   Palpi subequal or but slightly longer than the mandibles 8.
5. Tarsus of leg I longer than the tibia *R. longitarsus.*
   Tarsus of leg I not longer than the tibia 6.
6. Tarsus of tibia of leg I subequal in length *R. erythreus.*
   Tarsus of leg I much shorter than the tibia 7.
7. Tarsus of leg I not swollen *R. quadrioculus.*
   Tarsus of leg I quite swollen *R. brevitarsus.*
8. Integument of body with many small black spots *R. leprosus.*
   Integument of body without spots *R. parvipollicus.*

Rhyncholophus tridentifer n. sp.

Pl. VIII. f. 2–3.

Light red; appendages much paler than the body. Body well clothed with peculiar hairs or bristles. Each hair consists of three long prongs united at the base in such a manner as to form a trident; prongs of the trident equal, curved inward and pectinate on their outer margins.

Cephalothorax much reduced, about as broad as long. Palpi about one half as long as the anterior pair of legs; thumb small, not swollen, extending to the tip of the palpal claw; palpal claw about as long as the segment from which it extends, slightly curved; second segment of the palpus the largest, about one-half as broad as long. Mandibles two-thirds as long as the palpi. Dorsal groove extending the entire length of the cephalothorax with a circular expansion at about one-third its length from the posterior end; a long thread-like pair of hairs situated on this circular expansion which are about one-half as long as the groove itself. A single pair of eyes situated upon an oblong elevation about half way between the dorsal groove and the lateral margin of the cephalothorax.

Abdomen long, swollen in front between the first and second group of legs.

Anterior pair of legs about two-thirds as long as the body; tarsus longer and broader than the tibia; tibia and antepenultimate segment subequal. Second and third pair of legs subequal; hind pair of legs equal to the anterior pair and extending slightly beyond the posterior margin of abdomen. Tarsus and tibia of the last pair of legs subequal. All the legs well clothed with bristles.

Length, 0.90 mm.; breadth, 0.48 mm.

Common under the bark of soft maple trees and sometimes found under the bark of other trees. Collected by J. D. Hood at Urbana, Ill., and by the writer at Arcola and Muncie, Ill.

Rhyncholophus pollicaris n. sp.

Pl. VIII. f. 4.

Pale, yellowish pink. Body clothed with stout, simple spines.

Palpi as long as the first two segments of leg I; thumb greatly swollen, surpassing the palpal claw and well clothed with almost straight hairs; claw rather sharply curved downward; third segment of the palpus about one-half as long as the second. Dorsal groove extending about one-third its length beyond the eyes, swollen at its posterior end. A single pair of eyes present, situated at the level of the second pair of legs and about half way between the dorsal groove and the lateral margin.

Body small, about three-fifths as broad as long, broadly rounded behind. Posterior group of legs situated at about the middle of the abdomen.

All the legs very long, being much longer than the body. Anterior pair twice as long as the body; tarsus of leg I slightly swollen, about one-half as long as the tibia; tibia slightly longer than the preceding segment. Second pair of legs two-thirds as long as the anterior pair; third pair almost as long as the first pair. Last pair of legs the longest, being about two and a half times as long as the body; tarsus of leg IV very slightly swollen, less than one-third as long as the tibia; tibia and its preceding segment subequal.

Length, 0.90 mm.; breadth, 0.50 mm.

Found upon the bark of wild cherry. Collected by the writer at Urbana, Ill.

This species is remarkable for the great size of the palpal thumb and the length of the legs.

Rhyncholophus parvisetosus n. sp.

Pl. VIII. f. 5.

Body black; legs and mouth parts red; integument very finely and uniformly striated. Body very sparsely clothed with minute, scale-like setae (hence the name *parvisetosus*).

Palpi not as long as the first two segments of the anterior legs; palpal claw large, stout and possessing a row of four sharp teeth on its inner ventral aspect; thumb large, clavate, slightly surpassing the claw and well clothed with bristles. Dorsal groove extending into the anterior tubercle of the cephalothorax, which bears a whorl of ten long, stout, straight, slightly pectinate bristles.

Body subpyriform, the broadest part being between the anterior and posterior groups of legs; uniformly rounded posteriorly.

Anterior pair of legs about one-third as long again as the body; tarsus of leg I three-fourths as long as the tibia, slightly swollen; tibia subequal to its preceding segment. Second and third pair of legs shorter than the first pair and subequal. Last pair of legs much the longest, being about twice as long as the body; tarsus of leg IV not swollen, about two-fifths as long as the tibia; tibia about one and a half times

as long as the preceding segment. All the legs well clothed with short, pectinate bristles. Claws of all the legs moderate.

Length, 2.00 mm.; breadth, 1.40 mm.

Found in grass. Collected by the writer at Muncie, Ill.

This species apparently carries its young upon its back. I found several small larvae all alike (which presumably were the larvae of this species, as they had several characteristics of the adult) living parasitically upon the specimen.

Rhyncholophus longitarsus n. sp.

Pl. VIII. f. 6.

Almost uniform red. Body and legs well clothed with subspatulate, clavate hairs.

Palpi extending forward to about the middle of the third segment of leg I; palpal claw short, strongly curved; thumb slightly swollen, not surpassing the claw; second segment of palpus broader and one and one-half times as long as the third segment. Mandibles about one-half as long as the palpi. Dorsal groove long, extending over one-half its length beyond the eyes, swollen at the posterior end and extending anteriorly to the anterior tubercle which is small, low and bears about six stout hairs. A single pair of large eyes present, situated about half way from the dorsal groove to the lateral margin of the body.

Body subpyriform, broadest between the anterior and posterior groups of legs; uniformally rounded behind.

Anterior pair of legs as long as the body; tarsus slightly swollen, as long as the tibia; tibia subequal to the preceding segment. Second pair of legs small, about three-fourths as long as the anterior pair; third pair slightly longer than the second. Last pair of legs equal to the first pair in length; tarsus not swollen and shorter than the tibia.

Length, 1.45 mm.; breadth, 0.92 mm.

In trash. Described from three specimens sent to me by C. R. Crosby, from Columbia, Mo.

Rhyncholophus erythreus n. sp.

Pl. VIII. f. 7.

Red; body darker than the appendages. Body thickly clothed with short, stout, slightly pectinate hairs; hairs on the legs simple and longer than those of the body.

Cephalothorax not clearly separated from the abdomen. Palpi surpassing the first two segments of the first pair of legs; thumb small, not swollen and equal to the palpal claw; second segment of the palpus the longest, being both longer and stouter than the third segment; mandibles about three-fifths as long as the palpi. Dorsal groove extending slightly beyond the eyes; anteriorly it leads to a broad, low tubercle, which bears about a dozen large, stout, straight bristles. Eyes large, single and situated laterally.

Abdomen three-fifths as broad as long, broadly rounded behind; posterior group of legs situated about the middle.

Anterior pair of legs about a third longer than the body; tarsus slightly swollen and subequal to the tibia; tibia shorter than the antepenultimate segment. Second and third pair of legs subequal; last pair of legs extending about two-thirds their length beyond the posterior end of the body; tarsus of leg IV swollen, about one-half as long as the tibia; tibia thickly clothed with a row of subequal bristles resembling a comb; tibia and antepenultimate segment subequal.

Length, 0.90 mm.; breadth, 0.60 mm.

On a maple log. Collected by J. D. Hood at Urbana, Ill. Described from two well-preserved specimens.

Rhyncholophus quadrioculus n. sp.

Pl. VIII. f. 8–9.

Extremely variable in color, many of the smaller specimens light yellow or greenish, while most of the larger ones are red. In some of the larger specimens, the anterior legs, the tarsi of the second and the third pairs and the four distal segments of the last pair of legs are red, the remaining segments of the last three pairs of legs being almost colorless.

Palpi extending to about the middle of the third segment of the anterior pair of legs; palpal claw slender, curved downward; thumb small and slender, not extending to the tip of the palpal claw; second segment of palpus longer and broader than the third. Mandibles less than one-half as long as the palpi. Dorsal groove short, scarcely extending to the level of the eyes, expanded behind where is situated a pair of long bristles equal to the dorsal groove in length; anterior tubercle bearing six long subequal bristles. Two pairs of eyes present; situated laterally, the more lateral pair being much the smaller.

Body oval; two-thirds as broad as long, uniformly rounded behind.

Anterior pair of legs longer than the body; tarsus slightly swollen and two-thirds as long as the tibia; tibia subequal in length but narrower than its preceding segment. Second and third pairs of legs shorter than the rest, the second pair being the shortest. Hind pair of legs equal to the body in length; tarsus swollen, one-half as long as the tibia; tibia longer and narrower than its preceding segment.

Length, 0.86 mm.; breadth, 0.50 mm.

In grass. Very abundant in the vicinity of Arcola, Ill., during the autumn months. Described from many specimens.

Rhyncholophus brevitarsus n. sp.

Pl. IX. f. 10–11.

Color variable; body usually almost black; legs red, the second and third pairs usually lighter.

Palpi about one-third as long as the anterior pair of legs; palpal claw strongly curved inward; thumb one-third as broad as long, not swollen and not extending to the tip of the palpal claw; penultimate segment

of palpus one-half as broad as long; second segment of palpus the longest and broadest. Mandibles one-half as long as the palpi. Dorsal groove extending backward slightly beyond the level of the eyes. Two pairs of eyes present, the larger, posterior pair, situated one-half the distance from the dorsal groove to the lateral margin of the cephalothorax; just in front and lateral to this pair of eyes is a much smaller pair of eyes.

Abdomen two-thirds as broad as long, broadest at the insertion of the third pair of legs. Body rather sparsely clothed with short, feather-like hairs.

Anterior pair of legs one and a third times as long as the body; tarsus swollen, two thirds as long as the tibia; tibia narrower but equal in length to the antepenultimate segment. Second pair of legs slightly over two-thirds as long as the anterior pair; third pair slightly longer than the second. Last pair of legs almost as long as the first pair; tarsus swollen, about two-thirds as broad as long and one-third as long as the tibia; tibia longer and narrower than the antepenultimate segment.

Length, 0.80 mm.; breadth, 0.52 mm.

In grass. Collected by C. A. Hart at Hillery, Ill., and by the writer at Muncie, Ill. Described from two specimens.

Rhyncholophus leprosus n. sp.

Pl. IX. f. 12.

Yellow; body with many small black spots.

Cephalothorax cone-shaped, one-half as broad as the abdomen. Mandibles stout, about one-third as long as the anterior pair of legs; palpi equal to the mandibles in length; thumb and claw both short. Dorsal groove rather short, extending about one-fourth its length beyond the eyes; expanded at the posterior end, at the anterior end continuous with a small triangular elevation upon which are situated six straight, slightly pectinate bristles, the two largest consisting of a pair situated near the posterior margin of the elevation; toward the middle of the elevation is situated a similar but smaller pair; just in front and just behind this pair is situated a single median bristle. A single pair of eyes present, rather large, situated two-thirds the distance from the dorsal groove to the lateral margin.

Abdomen three-fifths as broad as long, broadly rounded behind and enlarged in front of the third pair of legs, moderately well clothed with small barbed hairs. The last two pairs of legs situated about the middle of the ventral surface of the abdomen.

Anterior pair of legs longer than the body; tarsus swollen, about three-fourths as long as the tibia. Second and third pair of legs subequal. Last pair of legs extending more than one-half their length beyond the posterior margin of the abdomen; tarsus of leg IV about one-third as long as the tibia; tibia longer but narrower than the antepenultimate segment.

Length, 0.98 mm.; breadth, 0.64 mm.

Found running over garden plants. Collected by the writer at Arcola, Ill.

Rhyncholophus parvipollicus n. sp.

Pl. IX. f. 13.

Body bright red; anterior pair of legs, the two proximal segments of the second and third pairs of legs and all the segments of the last pair of legs except the two distal, bright red; the four distal segments of the second and third pairs of legs and the two distal segments of the last pair of legs colorless.

Mandibles two-thirds as long as the palpi; distal segment of palpus including its claw a little over one-half as long as the penultimate segment; thumb small, extending to the end of the palpal claw and bearing at its end a tuft of long bristles; penultimate segment of palpus twice as long as broad. Dorsal groove of cephalothorax extending behind the eyes, swollen at its posterior end and at its anterior end continuous with a triangular tubercle which bears two pairs of bristles, the posterior of which is the smaller. A single pair of small eyes present, situated about two-thirds the distance from the dorsal groove to the lateral margin.

Body moderately well clothed with barbed hairs; abdomen broadest at the insertion of the third pair of legs. Posterior group of legs situated about two-thirds the distance from the anterior to the posterior end of the body.

Anterior pair of legs one and a half times as long as the body; tarsus of leg I but slightly swollen and less than the tibia in length; tibia about four-fifths as long as the antepenultimate segment. Second pair of legs very short, but over one-half as long as the anterior pair of legs; third pair of legs longer than the second. Hind pair of legs about equal to the anterior pair; tarsus about one-third as long as the tibia; tibia longer but narrower than the antepenultimate segment.

Length, 1.00 mm.; breadth, 0.64 mm.

Found in grass. Collected by the writer at Arcola, Ill.

Smaris Latreille.

Mouth parts very retractile, when drawn in, invisible; dorsal groove not swollen in the middle; an extra pair of eyes sometimes present on the anterior margin of the body.

One species.

Smaris longilinealis n. sp.

Pl. IX. f. 14.

Bright red; legs and mouth parts paler. Integument irregularly striated and bearing short, swollen, barbed setæ.

Mouth parts very small. Palpi weak, scarcely equal to the second segment of leg I; thumb small not swollen, equal to the palpal claw in length; penultimate segment equal in width to the second segment but shorter. Mandibles three-fifths as long as the palpi and bearing prominent hairs. Mouth parts borne upon a protrudable unsegmented stalk which when extended is equal to one-half the length of the anterior pair of legs. Dorsal groove extending over one-half of its length beyond the

eyes, enlarged at the posterior end, where two small simple hairs are situated, and extending forward to the anterior tubercle which bears a whorl of bristles like those of the body. A small single pair of eyes situated two-thirds the distance from the dorsal groove to the lateral margin.

Abdomen not separated from the cephalothorax. Body two-thirds as broad as long, broadly rounded behind.

Anterior pair of legs fully as long as the body; tarsus of leg I very slightly swollen, two thirds as long as the tibia; tibia not as long as the antepenultimate segment. Second pair of legs three-fifths as long as the anterior pair; third pair slightly longer than the second pair. Last pair of legs extending one-half their length beyond the posterior margin of the body; tarsus one-half as long as the tibia, not swollen; tibia slightly longer and narrower than the antepenultimate segment. All the legs clothed with hairs similar to those of the body.

Length, 1.68 mm.; breadth, 1.00 mm.

In moss. Collected by L. M. Smith at Marion, Ill.

TROMBIDIIDAE.

Last segment of palpus transformed into a thumb, penultimate ending in one or two strong palpal claws; cephalothorax small and frequently partially concealed by the protruding of the anterior part of the abdomen; eyes stalked; tarsi frequently swollen. Larvae parasitic upon insects. Adults usually predaceous.

TROMBIDIUM Fabricius.

Includes forms in which the palpus ends in a single stout claw.

Two species.

KEY TO SPECIES.

Body black, with the legs red	*T. subnigrum.*
Body and legs red	*T. missouriense.*

Trombidium subnigrum n. sp.

Pl. IX. f. 15.

Alcoholic specimens very dark brown; legs lighter.

Palpi about one-half as long as the anterior pair of legs; palpal claw long, stout and sharp; thumb of palpus not swollen and slightly surpassing the claw. With a double pair of eyes, two being situated on a single, short stalk on each side of the cephalothorax just above the anterior pair of legs. Just in front of the eyes is situated a transverse row of four straight, subequal bristles about twice as long as the eye stalks.

Body broadest at the anterior end and narrowest at the posterior end; subtruncate posteriorly and very sparsely clothed with simple hairs.

Anterior pair of legs slightly longer than the body; tarsi swollen and thickly clothed with fine hairs, somewhat shorter than the tibia; tibia slightly longer than the antepenultimate segment. Second and third

pair of legs subequal; last pair of legs extending about one-half their length beyond the posterior end of the abdomen. Claws of anterior pair of legs reduced in size; claws of other legs moderate.

Length, 1.00 mm.; breadth, 0.80 mm.

From trash. Collected by C. R. Crosby at Columbia, Mo.

Trombidium missouriense n. sp.

Pl. IX. f. 16.

Alcoholic specimens brown. Body somewhat furrowed dorsally.

Mouth parts large. Palpi two-thirds as long as the anterior pair of legs, with sharp stout claws; thumb of palpus clavate and surpassing the palpal claw. Palpi well clothed with hairs.

Abdomen subpyriform; broadest near the anterior end; broadly rounded behind and subtruncate in front; clothed thickly with barbed hairs.

Anterior pair of legs about as long as the body; tarsus of leg I subequal to the tibia in length but slightly swollen and more thickly clothed with finer hairs; tibia and antepenultimate segment subequal. Second and third pair of legs smaller than the others. Last pair of legs extending about one-third their length beyond the posterior end of the abdomen; tarsus of leg IV slightly longer than the tibia. All the legs provided with long, stout claws; ambulacra with a series of equal hairs resembling a comb.

Length, 1.00 mm.; breadth, 0.70 mm.

In trash. Collected by C. R. Crosby at Columbia, Mo. Two specimens.

GAMASIDAE.

Body with coriaceous shields; mandibles large, chelate; eyes wanting; first pair of legs not inserted in the same opening as the mouth parts; males often with the second pair of legs either enlarged or armed with spines or chitinous tubercles. Rarely parasitic. Nymphs frequently much resembling the adults.

Although this family is one of the richest in numbers, but very few species have been recorded from America.

MACROCHELES Latreille.

Peritreme present; leg I without claws; dorsal shield undivided; without post anal plate; hind femora unarmed; male genital aperture on anterior margin of sternum; male with second pair of legs slightly enlarged and usually provided with teeth.

Two species.

KEY TO SPECIES.

Posterior pair of legs extending two-thirds their length beyond the posterior margin of abdomen *M. clavisetosa.*

Posterior pair of legs extending less than one-half their length beyond the posterior margin of the abdomen *M. muscorum.*

Macrocheles clavisetosus n. sp.

Pl. IX. f. 17–18.

Light yellowish brown; integument granular.

Palpi one-half as long as the anterior pair of legs; distal segment less than the penultimate segment in length and bearing a tuft of hairs on its distal end; antepenultimate segment slightly longer than the penultimate; the second segment has its inner margin concave. Mandibles broader than the palpi; chelæ almost equal to the last two segments in length; hypostoma in the form of two long spurs, extending forward about one-half the length of the palpi.

Body about two-thirds as broad as long; markedly compressed in front of the second pair of legs and very broadly rounded behind. Dorsally the body is very sparsely clothed with rather stout spatulate hairs.

Anterior pair of legs longer than the body; tarsus and tibia of leg I subequal; tibia longer than the antepenultimate segment. Leg II enlarged, about three times as wide as leg I. The tarsi of the three last pairs of legs show segmentations near the base. Claws and caruncles stout. All the legs sparsely clothed with two kinds of hairs; near their bases the clavate hairs predominate while toward the distal ends only simple, pointed setæ are found.

Length, 0.90 mm.; breadth, 0.58 mm.

Quite common under logs and in trash. I have specimens from Galesburg, Arcola and Urbana, Ill.

Macrocheles muscorum n. sp.

Pl. IX. f. 19.

Very light brown; chelæ of mandibles dark brown.

Palpi one-half as long as the first pair of legs; distal segment longer than the penultimate segment; antepenultimate segment longer than the penultimate. Mandibles when extended equal to the palpi; chelæ as long as the last three segments of the palpus. Hypostoma in the form of two long harpoons and over one-half as long as the mandibles.

Body two-thirds as broad as long, rounded behind, truncate in front, slightly compressed at the level of the second pair of legs and very sparsely clothed with slightly curved hairs; hairs longer toward the posterior margin.

Anterior pair of legs as long as the body; distal segment one and a half times as long as the penultimate segment and well provided with hairs; penultimate and antepenultimate segments subequal; second pair of legs twice as stout as the first pair; third pair of legs the shortest pair; last pair of legs next to the longest. The last three pairs of legs possess stout caruncles.

Length, 0.46 mm.; breadth, 0.30 mm.

In moss. Collected by L. M. Smith at Parker, Ill.

Laelaps Koch.

Peritreme present, more than twice as long as broad; leg I with claws; dorsal shield entire; male genital opening on the anterior margin of the sternal plate, male with leg II unarmed.

Three species.

KEY TO SPECIES.

1. Body hairless *L. magnichela.*
   Body sparsely clothed with simple hairs 2.
2. Anterior pair of legs very slender, not as broad as the others *L. mandibularis.*
   Anterior pair of legs about as stout as the rest *L. flavus.*

Laelaps magnichela n. sp.

Pl. X. f. 20.

Chestnut brown; body darker than the appendages.

Palpi one-half as long as the anterior pair of legs; distal segment of palpus very small and short, as broad as long; penultimate segment slightly shorter than the antepenultimate; mandibles when extended equal to the palpi in length.

Body fully two-thirds as broad as long, somewhat egg-shaped in appearance. Peritreme straight, extending beyond the third pair of legs. Body hairless.

First pair of legs about as long as the body; tarsus of the first pair about one and a half times as long as the tibia; tibia and antepenultimate segment equal in length, but the tibia is somewhat the narrower of the two. Second pair of legs slightly the stoutest; tarsus of leg II one and a half times as long as the tibia; tarsus of leg III shorter than the tarsus of leg II. Tarsi of all the legs sparsely clothed with rather stout hairs. Claws of the tarsi moderate, situated on short pedicels.

Length, 0.64 mm.; breadth, 0.44 mm.

In moss. Collected by the writer at Muncie, Ill. Described from four specimens.

Laelaps mandibularis n. sp.

Pl. X. f. 21.

Yellowish brown, legs and mouth parts paler.

Palpi less than one-half as long as the anterior pair of legs; distal segment small, about one-half as broad and one-half as long as the penultimate segment; antepenultimate segment longer than the penultimate segment. Mandibles when extended twice as long as the palpi and apparently jointed near the middle; chelæ equal to the last two segments of the palpus in length.

Body egg-shaped, broadest at the level of the last pair of legs, sparsely clothed with simple hairs.

Anterior pair of legs about one and a half times as long as the body; tarsus one and a half times as long as the tibia and well clothed with hairs; tibia and antepenultimate segment subequal; second pair of legs stoutest and subequal to the third pair. Caruncles of the legs stout. All the legs sparsely clothed with hairs.

Length, 0.52 mm.; breadth, 0.42 mm.

Habitat unknown. Collected by the writer several years ago at Arcola, Ill. Described from two specimens, both of which were excellently well preserved.

Laelaps flavus n. sp.

Pl. X. f. 22.

Yellowish brown; legs paler than the body.

Palpi about one-half as long as leg I; mandibles stout, chelæ subequal.

Body broad, two-thirds as broad as long; broadly rounded behind and somewhat pointed in front. The whole of the dorsal surface of the abdomen is chitinized. Peritreme extending beyond the coxæ of the last pair of legs. Sternum in the case of the female almost as broad as long; genital plate of female large, truncate in front.

Anterior pair of legs about as long as the body; tarsus longer than the tibia, truncate at the distal end and bearing a small caruncle on its inner distal aspect. Second pair of legs slightly stouter than the others; third pair the shortest but stouter than the anterior pair; posterior pair of legs extending about one-third their length beyond the posterior margin of abdomen. Claws of the last three pairs of legs rather small and situated on slender pedicels.

Length, 0.52 mm.; breadth, 0.38 mm.

Under logs. Collected by the writer at Arcola, Ill. Two specimens.

Hyletastes Gistl.

Leg I with claws; dorsal shield entire; male genital opening on the anterior margin of sternal plate; leg II of male unarmed; anal plate small, separate in both sexes.

One species.

Hyletastes missouriensis n. sp.

Pl. X. f. 23–24.

Yellowish brown, integument smooth.

Palpi about one-half as long as the anterior pair of legs; distal segment very small, about one-half as broad and one-half as long as the penultimate segment; hypostoma with cusps about half as long as the basal segment of the palpus.

Body oblong, sides almost parallel for most of their length; broadly rounded behind and somewhat pointed in front. Dorsum hairless. Anal plate triangular with corners rounded and the anterior margin almost a straight line; genital plate almost twice as broad as the anal plate.

Anterior pair of legs almost as long as the body; tarsus about one and a half times as long as the tibia, truncate distally, with the caruncle arising from the inner side; antepenultimate segment shorter than the tibia. Second pair of legs slightly if any enlarged; tarsus of second pair of legs one and a half times as long as the tibia; third pair of legs shortest; fourth pair extending but slightly beyond the hind margin of the body.

Length, 0.50 mm.; breadth, 0.24 mm.

Under bark and in trash. Collected by C. R. Crosby at Columbia, Mo., and by the writer at Muncie, Ill.

GAMASUS Latreille.

Peritreme present, more than twice as long as broad; leg I with claws; dorsal shield large, entire; male with genital opening on the anterior margin of sternal plate; leg II of male frequently enlarged and armed with large chitinous horns or tubercles; sternal plate of female scarcely reaching the hind coxæ; genital plate of female triangular, being angulate anteriorly.

Three species.

KEY TO SPECIES.

1. Second pair of legs of male not swollen 2.
   Second pair of legs of male enormously swollen *G. magnicornutus.*
2. Second pair of legs of male provided with a sharp tooth on the inner side of each femur *G. oblongus.*
   Second pair of legs of male possessing a large horn *G. unicornutus.*

Gamasus oblongus n. sp.

Pl. X. f. 25.

Pale brownish grey; body darker than the appendages.

Palpi three-fifths as long as the anterior pair of legs; distal segment equal in length to the penultimate but not so stout; penultimate segment with a sharp spine at its inner distal aspect; antepenultimate segment both longer and stouter than the penultimate segment and bearing two small spines on its inner side; second segment, the stoutest of all and with one small spine on its inner side; mandibles stouter than the palpi and when extended may surpass the same, chelæ as long as the two distal segments of the palpus and uniformly toothed on their inner margins. The mandibles are jointed toward their middle. Cusps of the hypostoma sharp, slightly curved and about one-half as long as the chelæ of the mandibles.

Body broadly rounded behind and subtruncate in front, slightly compressed just above the second pair of legs. Dorsal surface of the body sparsely clothed with clavate bristles, including a prominent straight shoulder pair and a curved pair situated on the posterior margin.

Anterior pair of legs slightly longer than the body; tarsus one and a half times as long as the tibia; tibia and antepenultimate segment subequal. Claws of the anterior pair of legs smaller than the others and situated on very slender pedicels. Second pair of legs stouter than the rest; hind pair of legs as long as the anterior pair and with long slender tarsi. All the legs are provided with rather stout bristles.

Length, 0.50 mm.; breadth, 0.30 mm.

In moss. Collected by L. M. Smith, at Marion, Ill.

Gamasus unicornutus n. sp.

Pl. X. f. 26–27.

Light yellowish brown; chelæ of the mandibles darker brown than the rest of the body.

Mouth parts prominent. Palpi about one-half as long as the anterior pair of legs; distal segment equal to the penultimate and well clothed with hairs; antepenultimate segment stouter than the penultimate and curved upward. Mandibles when extended as long as the palpi; chelæ subequal, slightly toothed and about as long as the last two segments of the palpus. Epistoma and hypostoma apparently united to form a large tubular structure containing the mouth parts; above this structure shows three sharp cusps, one median and one on each side of this middle cusp.

Body almost twice as long as broad; slightly narrowed just in front of the second pair of legs, subtruncate in front and rounded behind. The body is sparsely clothed with moderate hairs and possesses a pair of shoulder bristles and a pair of anterior marginal bristles.

Genital opening of the male at the base of the hypostoma. Female genital plate extending from the anterior margin of the coxa of leg III to the posterior margin of coxa of leg IV. Anus in the case of both sexes situated near the posterior margin of the abdomen.

Legs slender; tarsi tapering. Anterior pair one and a third times as long as the body; second pair of legs stouter than the others in the case of both sexes and in the case of the male is provided with a large horn in the shape of a spur (hence the name *unicornutus*) which arises from the inner side of the femur. The tarsi of the last pair of legs are especially long and are provided with longer hairs than the other segments. Tarsal claws of all the legs small and situated on long, slender pedicels.

Length of male, 0.70 mm.; breadth of male, 0.32 mm.; length of female, 0.70 mm.; breadth of female, 0.40 mm.

Found in moss. Collected by J. D. Hood on the University campus, Urbana, Ill.

Gamasus magnicornutus n. sp.

Pl. X. f. 28.

Yellowish brown; body darker than the appendages.

Mouth parts large; palpi about one-third as long as the first pair of legs; distal segment of palpus broader but equal in length to the penultimate; antepenultimate segment both longer and stouter than the penultimate; palpi sparsely clothed with short, simple bristles. Epistoma of the male broad, with a shallow notch in the middle and two short points on each side; hypostoma prominent.

Body elongate, twice as long as broad, broadest at the insertion of the last pair of legs. The entire upper surface of the body is corneous and sparsely clothed with rather small, simple hairs. At the anterior margin of the body is situated a prominent pair of simple, curved bristles about one-half as long as the palpi.

Anterior pair of legs much longer than the others; tarsus and tibia of leg I subequal, each provided with several rather prominent bristles. The second pair of legs in the male are remarkable for their enormous size, each being about one-half as thick as the body is at the point where the legs are attached to it. The femur of the second pair of legs

of the male is the thickest segment; the genual, however, is almost as stout and bears on its inner dorsal aspect an enormous horn of a very characteristic shape and which is fully as long as the segment itself; tibia about one-half as broad as the genual and possessing a prominent quadrate horn on its inner side; tarsus of the usual size. Caruncles of the tarsi of all the legs rather slender. Legs sparsely clothed with hairs.

Length, 1.10 mm.; breadth, 0.70 mm.

Under the bark of a rotting maple log. Collected by J. D. Hood at Lyons, Ill.

UROPODIDAE.

Body with coriaceous integument, usually much depressed and often possessing impressed foveæ on the ventral surface for the reception of the legs when folded under the body. Mandibles chelate and retractile. First pair of legs inserted within a common body opening with the mouth parts. Nymphs possessing an anal pedicel composed of excreted material for adhering to the integument of insects. Not usually true parasites.

UROPODA Latreille.

Ventral surface of the body showing deep sculptures for the reception of the legs; body outline oval, not broken; dorsum sometimes pitted but never sculptured; leg I possessing claws.

Five species.

KEY TO SPECIES.

1. Integument of body deeply and uniformly pitted, pits large	*U. cribraria.*
Integument of body smooth	2.
2. Body uniformly rounded behind	3.
Body pointed behind	*U. folsomi.*
3. Antero-lateral margin of body convex	*U. illinoiensis.*
Antero-lateral margin of body concave	4.
4. Body almost as broad as long	*U. fusca.*
Body about two-thirds as broad as long	*U. pallida.*

Uropoda cribraria n. sp.

Pl. X. f. 29.

Brown; integument very coarsely pitted, giving the whole body a sieve-like appearance.

Body oblong, uniformly rounded behind and somewhat pointed in front, with a row of stout curved bristles around the margin. Female genital plate much more finely pitted than the rest of the body, about three-fifths as broad as long and extending from behind the coxæ of the last pair of legs to between the second pair of legs. Male genital opening on the median line half way between the third and fourth pair of legs.

Anterior pair of legs scarcely one-half as long as the body; tarsus of leg I almost as long as the three middle segments and well clothed

with hairs; tibia very slightly longer than the genual; genual about one-half as long as the femur. Second and third pair of legs shorter than the others. Tarsus of leg IV about three times as long as the tibia. The tarsi of the different legs have caruncles, whose pedicels increase in length as you go from the anterior to the posterior legs; claws of caruncles weak. Legs with very few hairs.

Length, 0.54 mm.; breadth, 0.30 mm.

Found under the bark of both the sycamore and the soft maple. Collected by J. D. Hood at Lyons and Urbana, Ill., and by C. A. Hart at Muncie, Ill.

Uropoda folsomi n. sp.

Pl. XI. f. 30.

Chestnut brown; anterior part of the body lighter than the rest.

Palpi scarcely extending beyond the anterior margin of the dorsum of the body and clothed with rather prominent hairs.

Body much longer than broad, somewhat pointed at each end and sparsely clothed with short hairs including a row around the margin of the body which is longer than the rest. Epigynium of the female almost twice as long as broad, broadest at the middle, extending from the level of the coxæ of legs II to about midway between the coxæ of legs III and legs IV. Genital opening of male oval, with the long diameter in the line of the median plane, situated between the coxæ of the third pair of legs.

First pair of legs about one-third as long as the body; tarsus one and a half times as long as the tibia and genual combined, possessing a long slender caruncle and a long tactile bristle at its distal end. Second pair of legs slightly the stoutest; third pair not extending to the posterior end of the body. All the legs bear a few short, stout, sharp spines.

Length, 1.04 mm.; breadth, 0.64 mm.

Habitat not known. Collected by J. W. Folsom at Urbana, Ill. Described from one male and two females.

Uropoda illinoiensis n. sp.

Pl. XI. f. 31.

Chestnut brown; integument smooth.

Mouth parts of moderate size; palpi one-third as long as the anterior pair of legs; sparsely clothed with hairs.

Body subdiscoidal, almost as broad as long; sparsely clothed with very small hairs, with a small pair of hairs at the tip of the anterior margin. Epigynium of the female long and narrow, twice as long as broad and extending from between the coxæ of the second pair of legs to even with the posterior edge of the coxæ of the last pair of legs. Genital opening of the male a little posterior to the level of the third pair of legs; sternum of the male somewhat pitted with large shallow pits.

Anterior pair of legs about one-third as long as the body; tarsus of leg I equal to the genual and tibia combined and clothed with moderate hairs; tibia and genual subequal in length but the genual is the stouter;

femur two-thirds as broad as long. Second pair of legs stouter than the other pairs; hind pair the longest. Claws of the tarsi stout and in the case of the hind pair of legs situated on rather long pedicels. All the legs very sparsely clothed with hairs.

Length, 0.76 mm.; breadth, 0.58 mm.

Found under bark and under old logs. Collected by the writer at Arcola and Urbana, Ill. Described from four specimens.

Uropoda fusca n. sp.

Pl. XI. f. 33.

Chestnut brown, the anterior part of the body being lighter than the rest.

Body almost disc-shaped, but slightly longer than broad, with the anterior margin projecting somewhat. Posterior margin of the sternal plate of the male concave; male genital opening situated about its width from the posterior margin of the sternum. Anus small, situated about its width from the posterior margin of the abdomen.

Anterior pair of legs about one-third as long as the body; tarsus of leg I over twice as long as the tibia and possessing several long hairs; tibia and genual subequal; femur broader than the genual, being almost as broad as long. Second pair of legs slightly longer than the first pair; tarsus of leg II one and a half times as long as the tibia; fourth pair of legs not extending to the posterior border of the body. All the legs are provided with moderately stout caruncles.

Length, 0.50 mm.; breadth, 0.38 mm.

Found under bark by J. Douglas Hood at Muncie, Ill.

Uropoda pallida n. sp.

Pl. XI. f. 34.

Light chestnut brown, with the anterior parts paler than the posterior.

Palpi two-thirds as long as the anterior pair of legs; distal segment of the palpus very small; penultimate segment subequal in length to the antepenultimate segment but narrower. Mandibles with stout, dentate chelæ, the inner digit of the chela slightly surpassing the outer. Hypostoma peculiar in possessing besides the two common cusps, two lateral fork-like structures, each bearing three prongs.

Body rounded behind but somewhat pointed in front; sparsely clothed with very fine hairs. Genital opening of the male situated near the middle of the sternal plate betwen the third pair of legs. Peritreme in the form of two loops, an anterior loop which is the largest and extends to the lateral margin of the body and a smaller posterior loop.

Anterior pair of legs one-half as long as the body; tarsus of leg I longer than the genual and tibia combined and possessing rather large hairs on its outer margin. Last pair of legs about equal to the anterior pair in length and not extending to the posterior margin of the abdomen.

The tarsal pedicels of the caruncles increase in length as you go backward from the anterior legs.

Length, 0.46 mm.; breadth, 0.28 mm.

No habitat recorded. Collected by the writer at Mahomet, Ill.

UROSEIUS Berlese.

No sculptures on the ventral surface of the body for the reception of the legs; leg I without claws; body without ventral plate; legs without scale-like hairs.

One species.

Uroseius badius n. sp.

Pl. XI. f. 35.

Dark reddish brown; integument rough.

Mouth part of moderate size; palpi over half as long as the anterior pair of legs; epistoma broad, quadrate, with a row of six sharp, short teeth on the anterior margin.

Body about three-fifths as broad as long, broad and uniformly rounded behind, narrowed anteriorly and truncate above the epistoma. Dorsal shield extending over the greater part of the upper surface of the body but there is a long chitinous strip on each side of the dorsal shield. Dorsum very sparsely clothed with short bristles. Sternum angulate anteriorly; female genital plate extending from between the coxæ of the last pair of legs to between the coxæ of the second pair of legs and ending anteriorly in a shady chitinous point. Anus situated about its width from the posterior margin of the abdomen.

Anterior pair of legs not more than one-third as long as the body; tarsus of leg I equal in length to the tibia and genual combined and ending distally in two tactile hairs, the outer of which is as long as the segment itself, the inner about half as long. The inner margin of the tarsus of leg I is hairless, while on the outer margin near the end is a tuft of hairs. Second pair of legs slightly stouter than the rest; last pair not extending to the posterior end of the body. Last three pairs of legs with stout claws.

Length, 1.04 mm.; breadth, 0.78 mm.

Under bark on a rotten cottonwood log. Collected by J. D. Hood at Urbana, Ill. Described from two well-preserved females.

DINYCHUS Kramer.

Without sculptures on the ventral surface of the body for the reception of the legs; leg I with claws; dorsal plate entire and fused to the ventral plate; peritreme sinuate; coxæ of the anterior pair of legs contiguous.

One species.

Dinychus ovatus n. sp.

Pl. XI. f. 36.

Dull pink; legs more uniformly colored than the body.

Body two-thirds as broad as long, very broadly rounded behind and pointed in front, broadest at the insertion of the last pair of legs. Body with a few fine hairs. Peritreme straight with the exception of a single outward loop near the middle.

Anterior pair of legs a little over one-third as long as the body and of almost uniform width throughout; tarsus one and a half times as long as the tibia and genual combined, almost hairless on the inner margin but with a tuft of hairs on the outer distal aspect; tibia slightly longer than the genual; femur twice as long as the genual. Last three pairs of legs subequal; posterior pair extending to the posterior margin of the abdomen. Claws of the last three pairs of legs moderate but situated on long pedicels; claws of the anterior pair of legs weak. The last three pairs of legs are provided with a few small, short but sharp spines.

Length, 0.50 mm.; breadth, 0.38 mm.

Under a log. Collected by the writer at Urbana, Ill.

Oribatidae.

Cephalothorax with a pair of specialized setæ arising from two large pores situated in the dorsal integument near the posterior end; abdomen with chitinous wing-like expansions called pteromorphæ; integument well chitinized and generally with a smooth surface. Nymphs without tracheæ or chitinized integument; adults with tracheæ opening at the acetabula of the legs.

This family is the same as the division Pterogasterea of some authors and the same as the subfamily Oribatinae of Michael in "Das Tierreich" 3. 1898.

Oribata Latreille.

Abdomen with chitinous wing-like expansions and bearing no spatulate bristles; lamellae attached to the cephalothorax by their inner margins; tarsi with tridactyle claws, tarsus of leg I never broadened at its distal end.

One species.

Oribata oblonga n. sp.

Pl. XI. f. 37.

Light brown; integument smooth.

Cephalothorax as broad as long. No true lamellæ present but instead a pair of lateral lamellæ which closely adhere to the integument. Lamellar hairs slightly curved and slightly pectinate, about one-half as long as the cephalothorax itself; antero-lateral hairs similar to lamellar hairs but smaller. Pseudostigma cup-shaped, slightly projecting; pseudo-

stigmatic organ with long, narrow pedicel and large clavate head, the anterior margin of which is strongly pectinate.

Abdomen almost twice as long as broad. Pteromorphæ small, truncate anteriorly and not projecting beyond the anterior margin of the abdomen, attached to the anterior half of the same. Genital covers smaller than the anal covers and situated a little over their length in front of the latter. Abdomen hairless.

Tarsus and tibia of leg I subequal; tarsus well clothed with hairs; tibia sparsely clothed with hairs but possessing a large tactile hair arising from a small tubercle at the distal, lateral aspect. Claws of tarsus monodactyle.

Length, 0.44 mm.; breadth, 0.26 mm.

In trash. Collected by C. R. Crosby at Columbia, Mo.

TYROGLYPHIDAE.

Body soft; without tracheæ; legs supported by rod-like epimera; palpi of three segments; eyes wanting; legs arranged into two groups and ending in claws, tarsi of legs I and II with a specialized clavate hair. Young frequently passing through a migratory stage, known as the hypopial stage in which they attach themselves to insects by means of a number of disc-like suckers on the ventral surface of the body.

TYROGLYPHUS Latreille.

Mandibles chelate; cephalothorax and abdomen divided by a suture; cephalothorax with four large posterior bristles; integument not granular; ventral apertures small; male with anal suckers; tarsi rather slender, provided with distinct claws, and in some species with spines.

One species.

Tyroglyphus magnisetosus n. sp.

Pl. XI. f. 38.

Brownish grey; legs lighter than the body.

Cephalothorax broad, three-fourths as long as the abdomen. Anterior pair of bristles slightly curved, almost one-half as long as the posterior bristles; posterior bristles subequal, fully as long as the abdomen.

Abdomen oval, two-thirds as broad as long and bearing about twenty large, long, almost straight, simple bristles, the longest of which are fully as long as the entire body. The bristles of the abdomen are distributed as follows—a transverse row of six bristles situated near the anterior margin, the two outer of these bristles being much smaller than the rest; a transverse row of four large, subequal bristles situated near the middle of the body; a group of eight bristles situated at the posterior end of the abdomen.

Legs moderate; anterior pair about as long as the abdomen. Tarsus of leg I twice as long as the tibia; sense hair situated its length from the posterior margin of the tarsus; tarsus without stout spines, but pos-

sessing four rather long bristles, three at the distal end of the segment and one near the middle; about half a dozen other very minute bristles present. Claw of tarsus I stout, somewhat longer than the width of the segment. Tibia of leg I almost as broad as long and possessing a long tactile bristle about three times as long as the segment itself.

Length, 0.40 mm.; breadth, 0.22 mm.

Under a log. Collected by the writer at Arcola, Ill.

This species is noted especially for the large size of the bristles on the body.

Rhizoglyphus Claparède.

Integument not granular; mandibles chelate; suture dividing the cephalothorax from the abdomen; only two large posterior bristles on the dorsal surface of cephalothorax; ventral apertures small; male with anal suckers; in some cases a dimorphic male may exist with the third pair of legs enormously developed. Tarsi short, stout; with some stout spines and distinct claws.

One species.

Rhizoglyphus oblongus n. sp.

Pl. XI. f. 39.

Dull, brownish grey; legs paler.

Cephalothorax long, about twice as long as broad. Mandibles stout, their length, as seen from above, equal to about one-third that of the cephalothorax. Anterior bristles slightly curved, situated on the anterior margin of the cephalothorax and extending to almost the tip of the mandibles; the two posterior bristles as long as the cephalothorax itself and situated near the lateral margins of the same; a very small pair of bristles is present between the large posterior bristles.

Abdomen large, almost twice as long as broad and possessing few prominent bristles; the largest pair being the shoulder bristles, which are almost as large as the posterior bristles of the cephalothorax. Besides the shoulder bristles there is a pair of lateral bristles about one-half as long as the shoulder bristles situated about two-thirds the distance from the anterior to the posterior end of the abdomen, also a pair of similar posterior marginal bristles and a pair of bristles situated dorsally about their length from the posterior margin.

Tarsus of leg I half as long again as the tibia; sense hair situated about two-thirds its length from the proximal end of the segment. No large spine near the sense hair, there is however a very small spine, about two-thirds as long as the sense hair itself, situated approximate to it on its inner side. Just above the tarsal claw is situated a very large, stout spine about two-thirds as long as the claw itself; on the inner margin of the tarsus about one-third the distance from the distal to the proximal end of the segment is a small, sharp spine directed forward; just posterior and dorsal to this spine is a long slender one about three times as long; on the outer posterior aspect is situated a small spine. Distally the tarsus of leg I bears two lateral and one

dorsal bristle, each about two-thirds as long as the segment itself. Tibia almost as broad as long and subsequent to the genual.

Length, 0.62 mm.; breadth, 0.32 mm.

Collected from corn grains by E. O. G. Kelly at Leroy, Ill. Described from many specimens.

EXPLANATION OF ILLUSTRATIONS.

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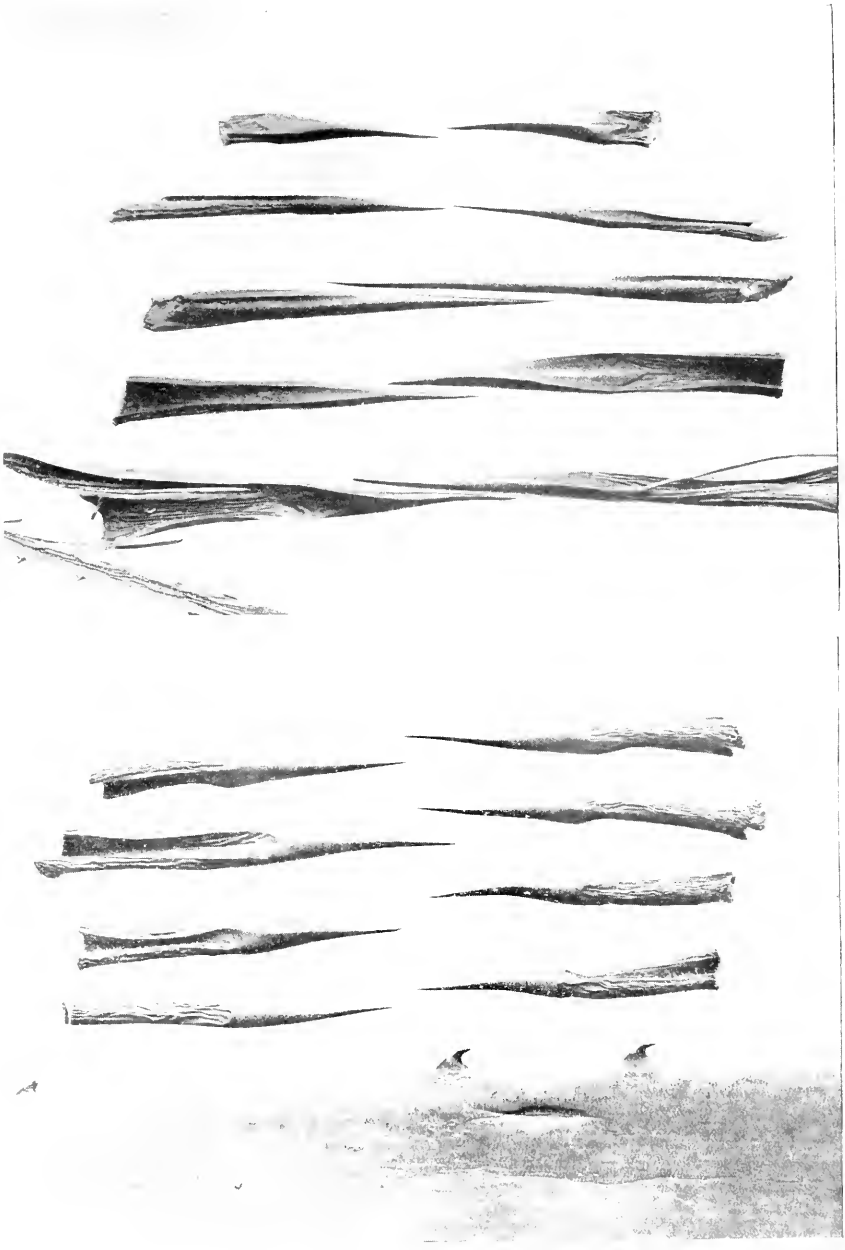

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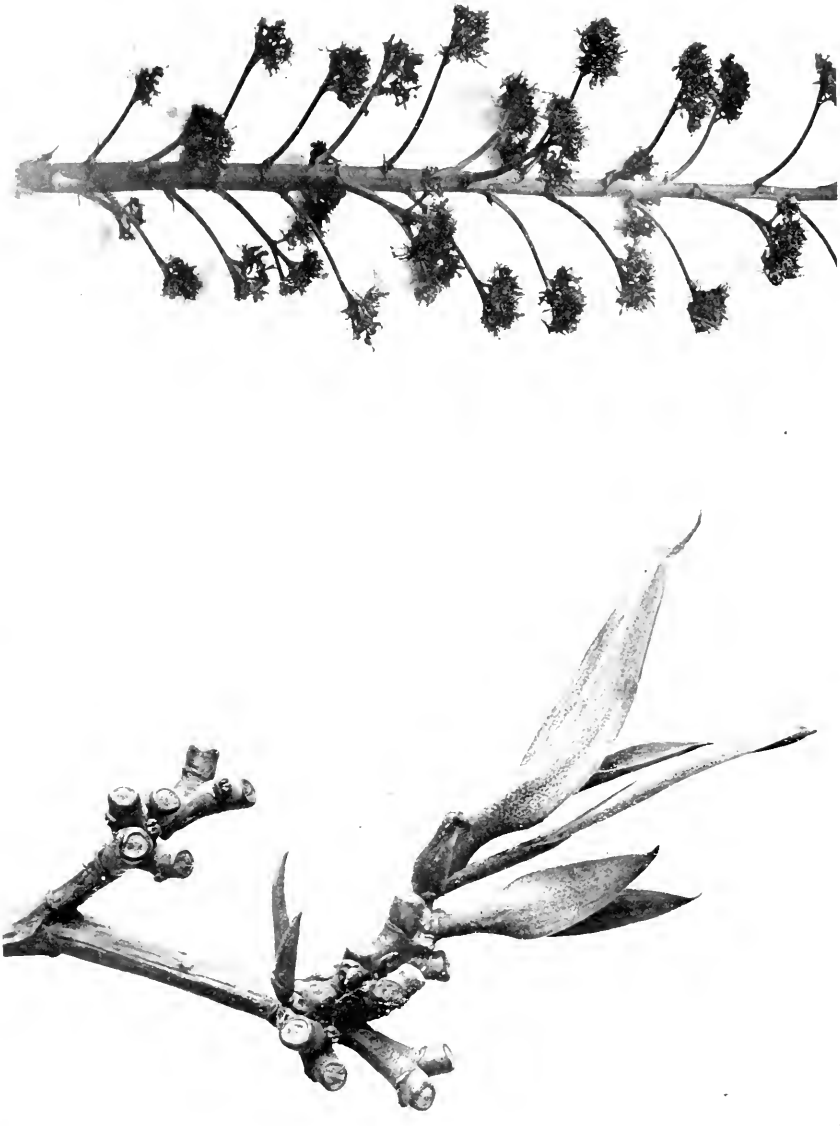

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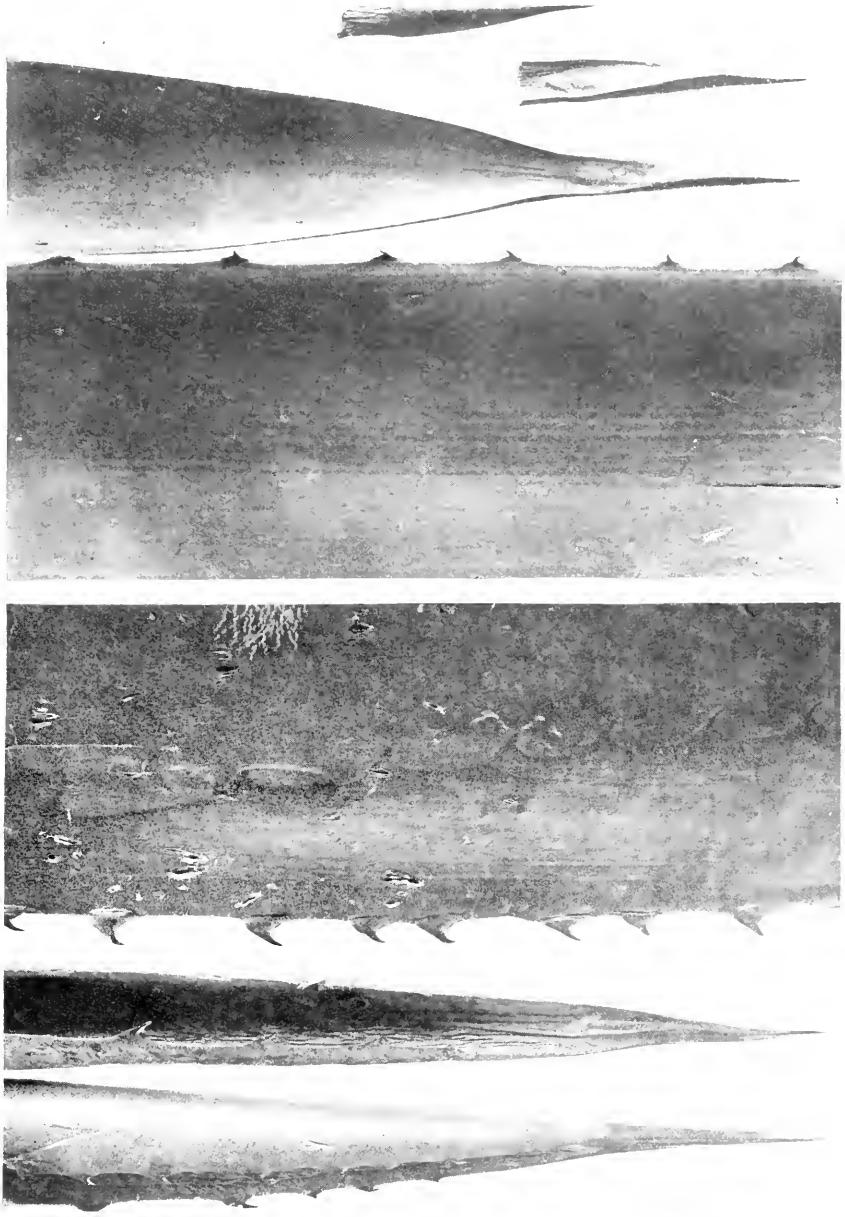

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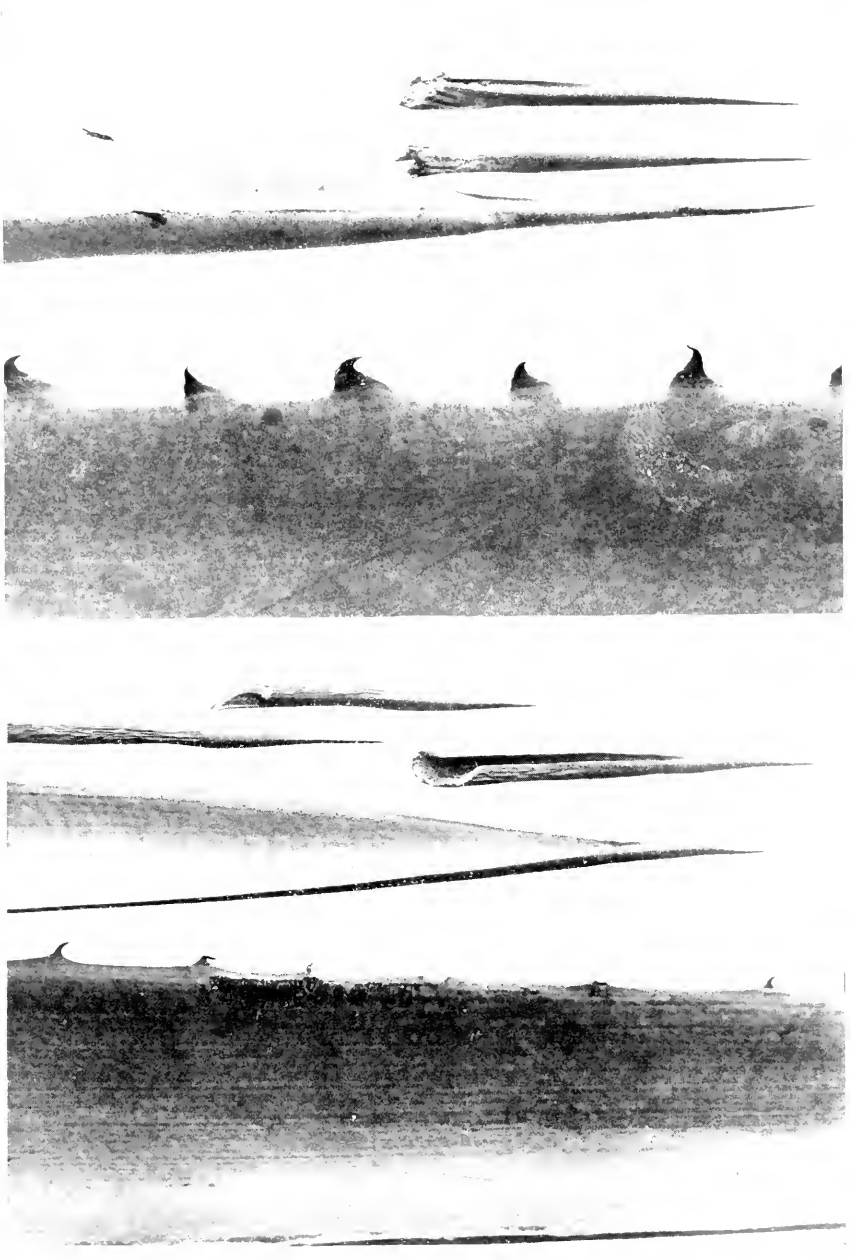

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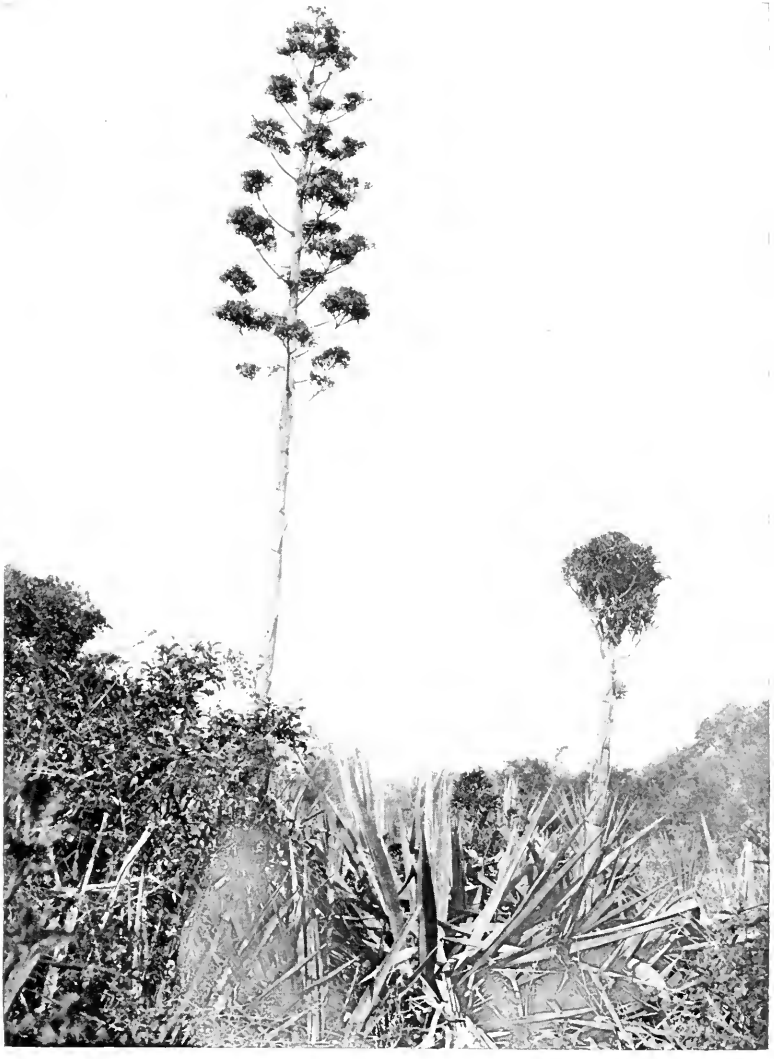

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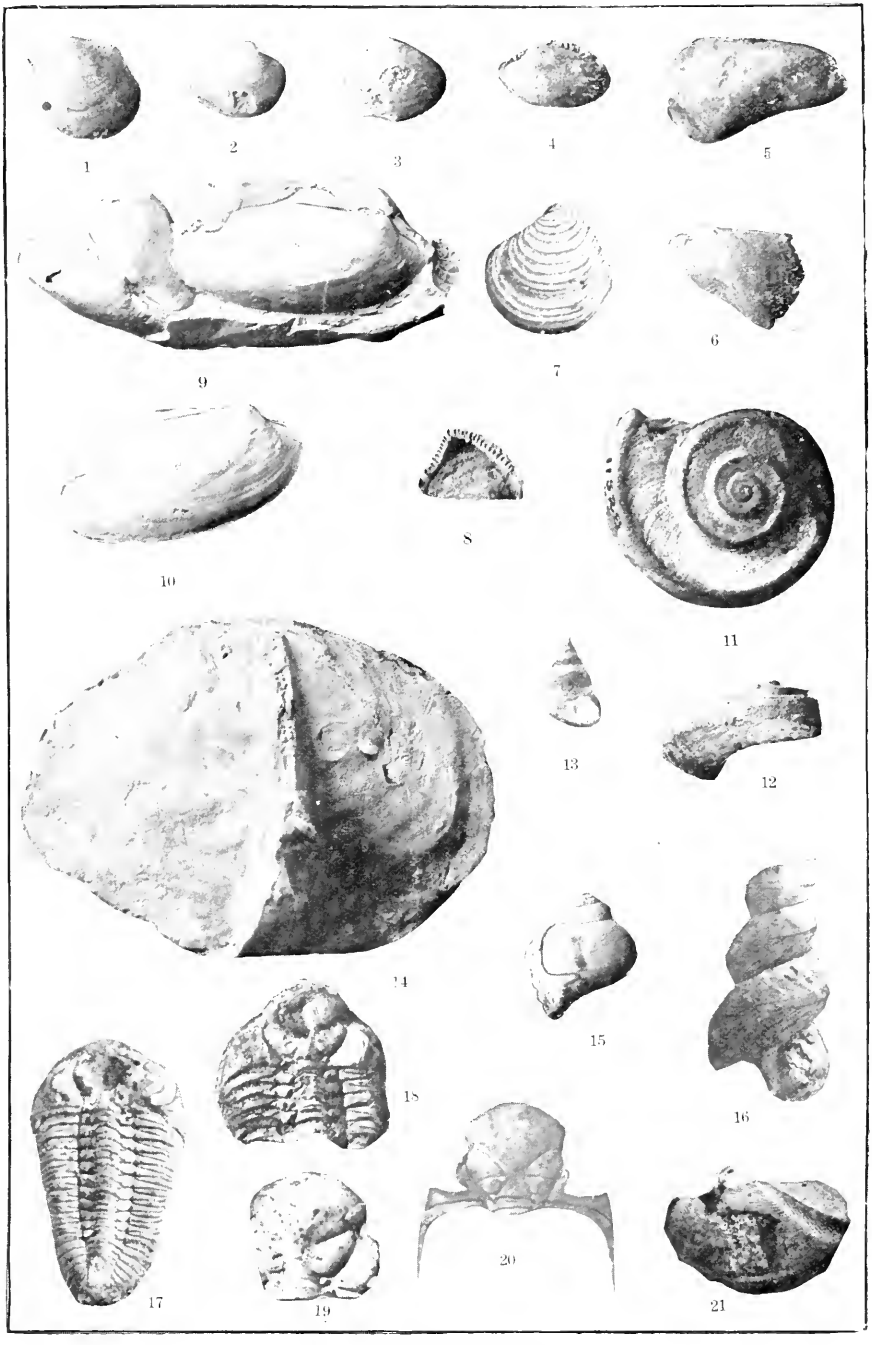

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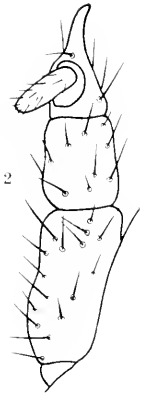
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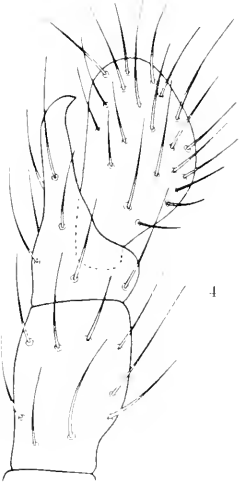
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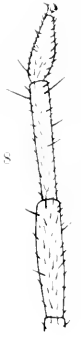
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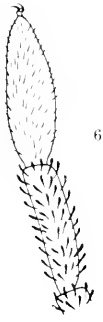
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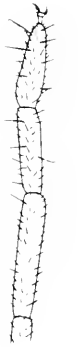
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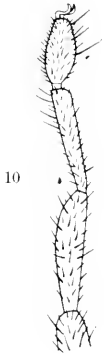

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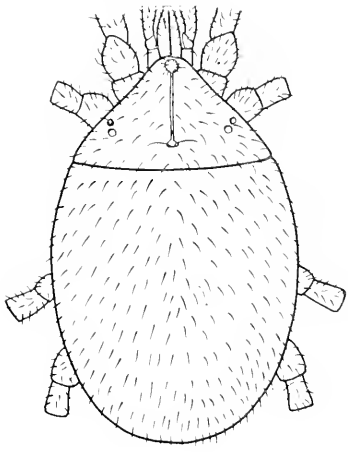

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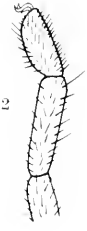

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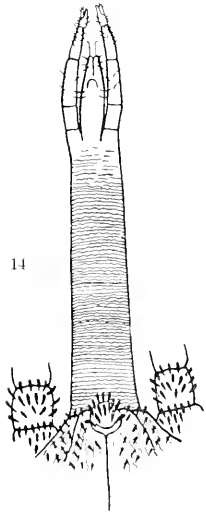

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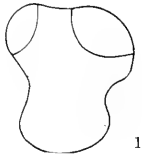

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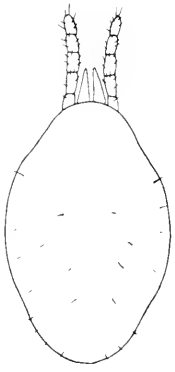

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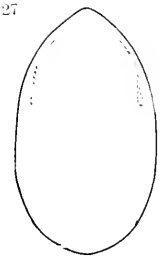

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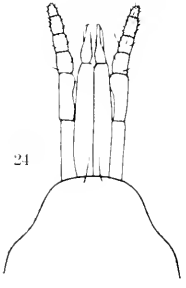

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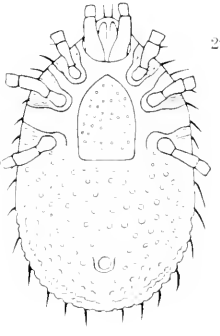

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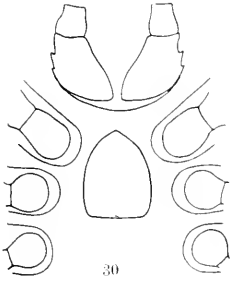

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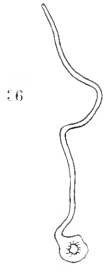

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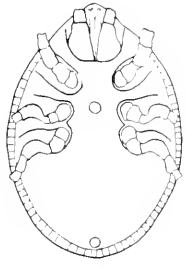

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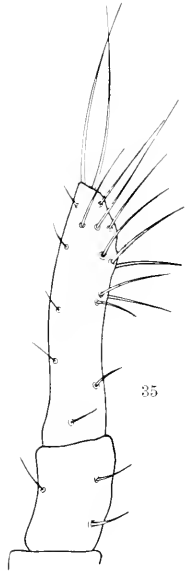

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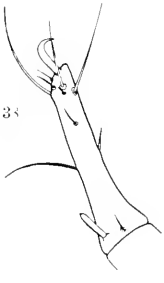

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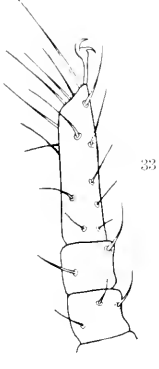

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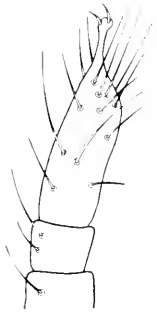

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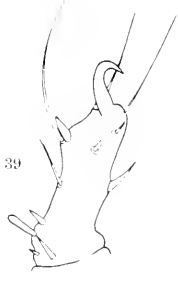

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